THE ENGINEER

SEPTEMBER 25, 1959 | 28 ESSEX STREET, STRAND, LONDON, W.C.2 | TWO SHILLINGS

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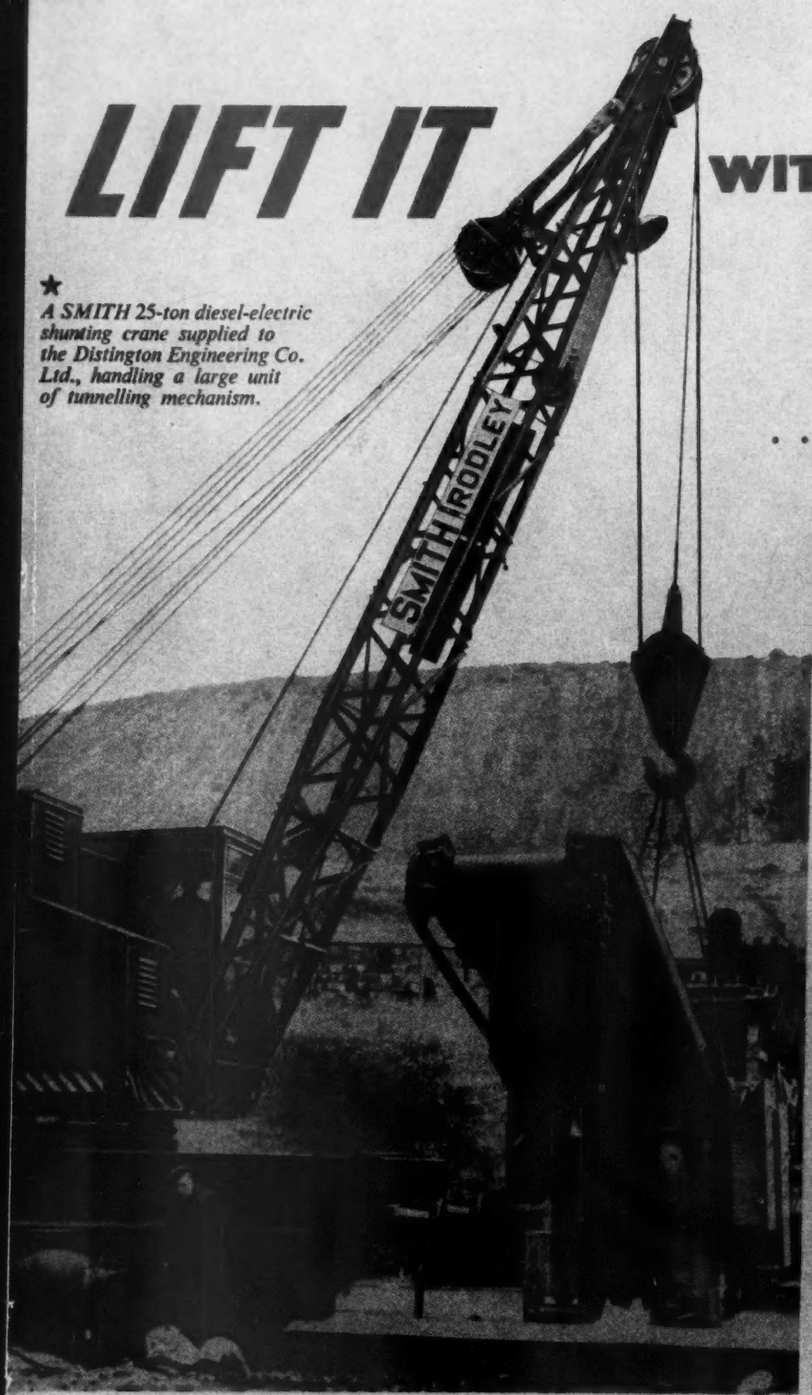

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Established 1856

No. 5409 SEPTEMBER 25, 1959 VOL. 208

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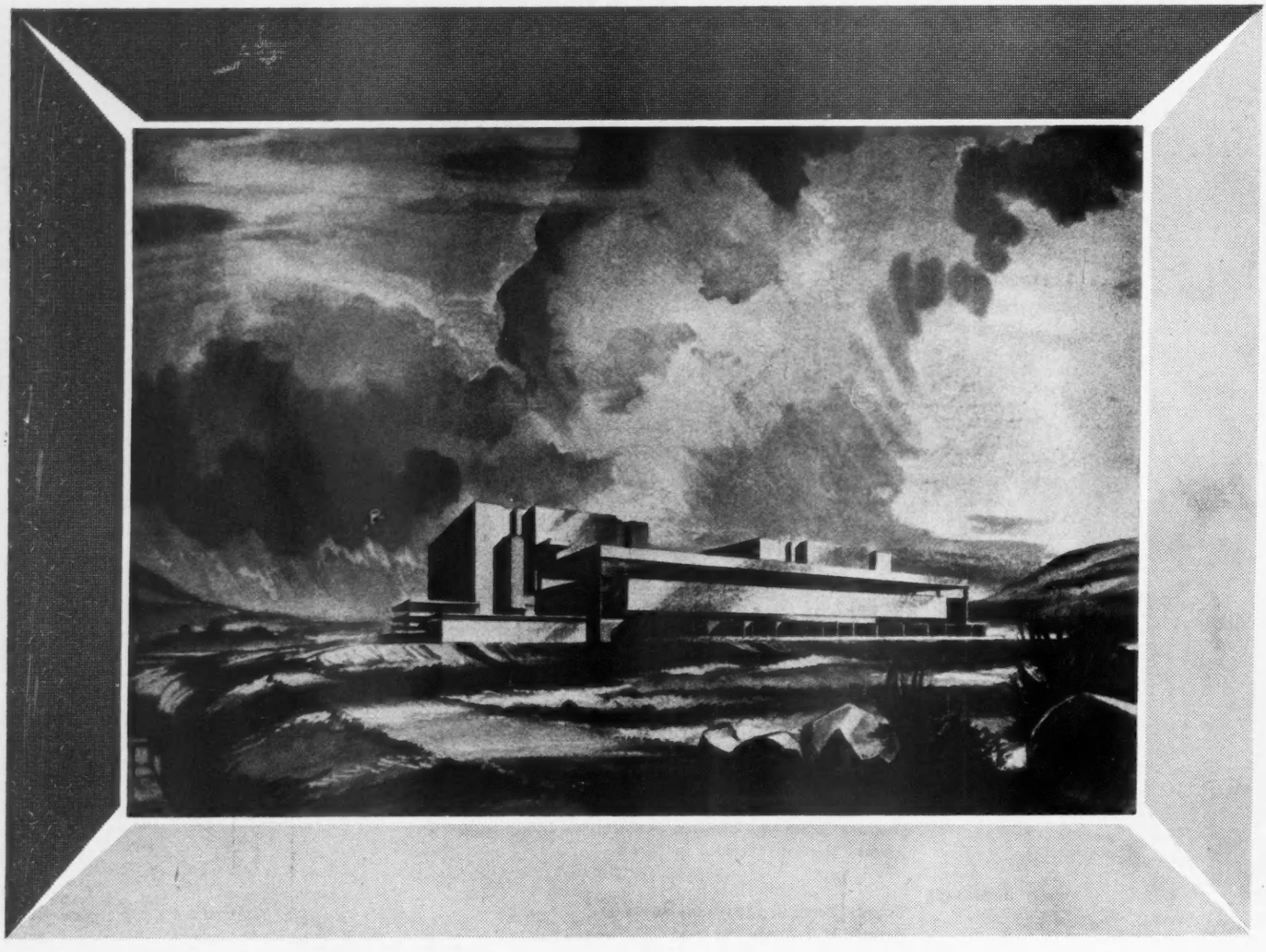

Generating Plant for Trawsfynydd

The whole of the generating, condensing and feed heating plant as well as the CO_2 circulators for the 500 MW Nuclear Power Station to be built by Atomic Power Constructions Ltd., at Trawsfynydd in North Wales, will be made by the Richardsons Westgarth Group.

THE TURBO-ALTERNATORS, four in number, each with an electrical output of 145 MW, will be four cylinder machines of Brown Boveri design for a 65 per cent high pressure; 35 per cent low pressure steam cycle. The steam conditions at the turbine stop valves will be; H.P. 927 p.s.i.g. 715°F; L.P. 290 p.s.i.g. 685°F. Each turbine will discharge through six exhausts into twin condensers.

CONDENSING AND FEED HEATING PLANT. In addition to the eight turbine condensers, The Richardsons Westgarth Group are supplying the complete feed heating plant and also two dump condensers, each capable of handling 6% of the full heat output of one reactor.

THE TWELVE AXIAL-FLOW GAS CIRCULATORS will be of a new type designed and developed by the Group Engineering Division, and will be fitted six to each reactor at the lower ends of the boilers where they will handle CO_2 at approximately 240 p.s.i.g. Each circulator will be driven by an induction motor of approximately 6,000 h.p. at a constant speed of 2,950 r.p.m., the gas flow being regulated by throttle valves in the main gas ducts linked to bypass valves in the re-circulating ducts.

The large well co-ordinated resources of the Group make it possible for us to undertake this very considerable manufacturing programme without prejudicing the ability of our Works at Hartlepool to build turbo-alternators and other plant for industrial users.

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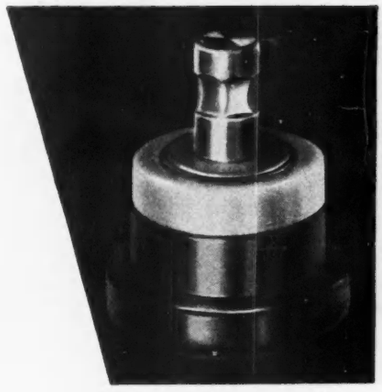
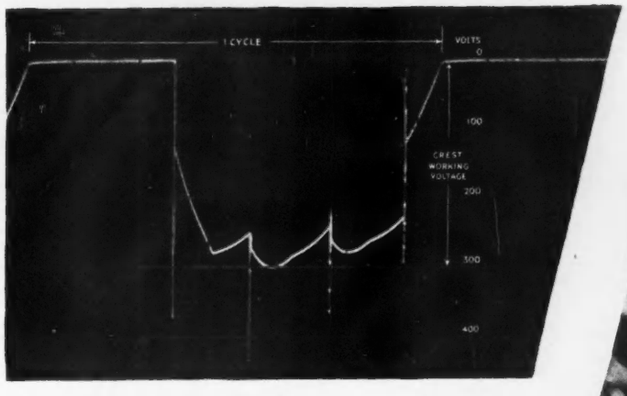
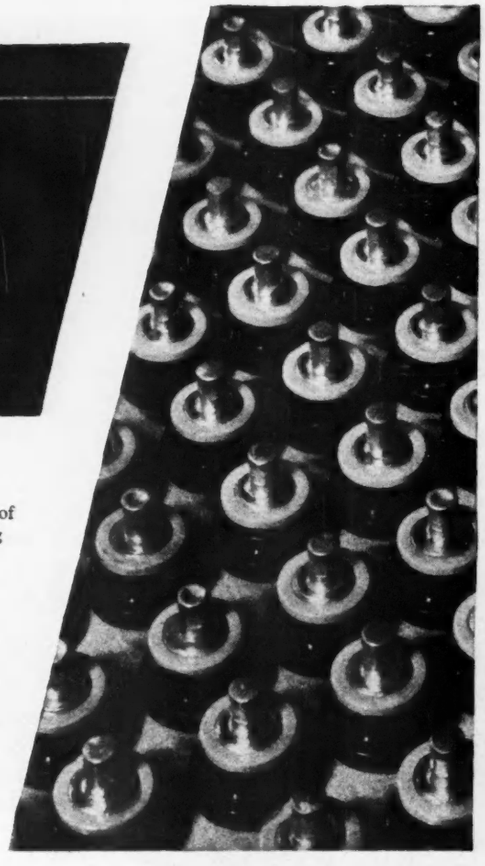


Crest working voltage 300 volts





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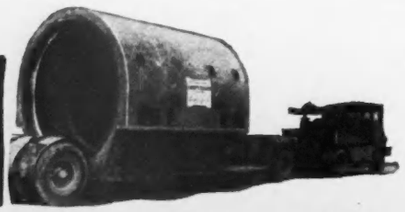

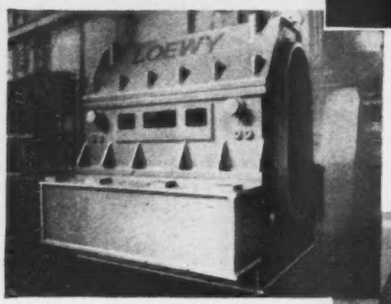

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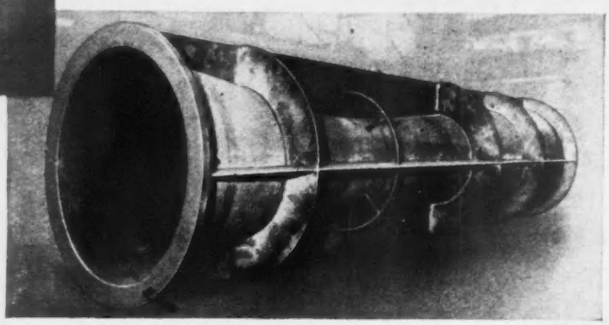

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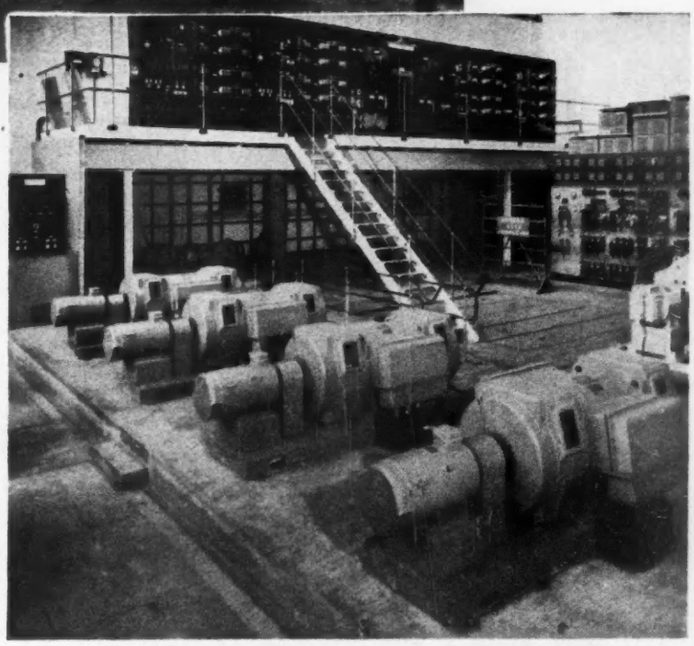

Some of the 210 floating-type motors, and the N-S frequency convertor equipment, providing 36 r.p.m. gearless drive for slab transfer table rolls, at the Abbey Works of the Steel Company of Wales Ltd.

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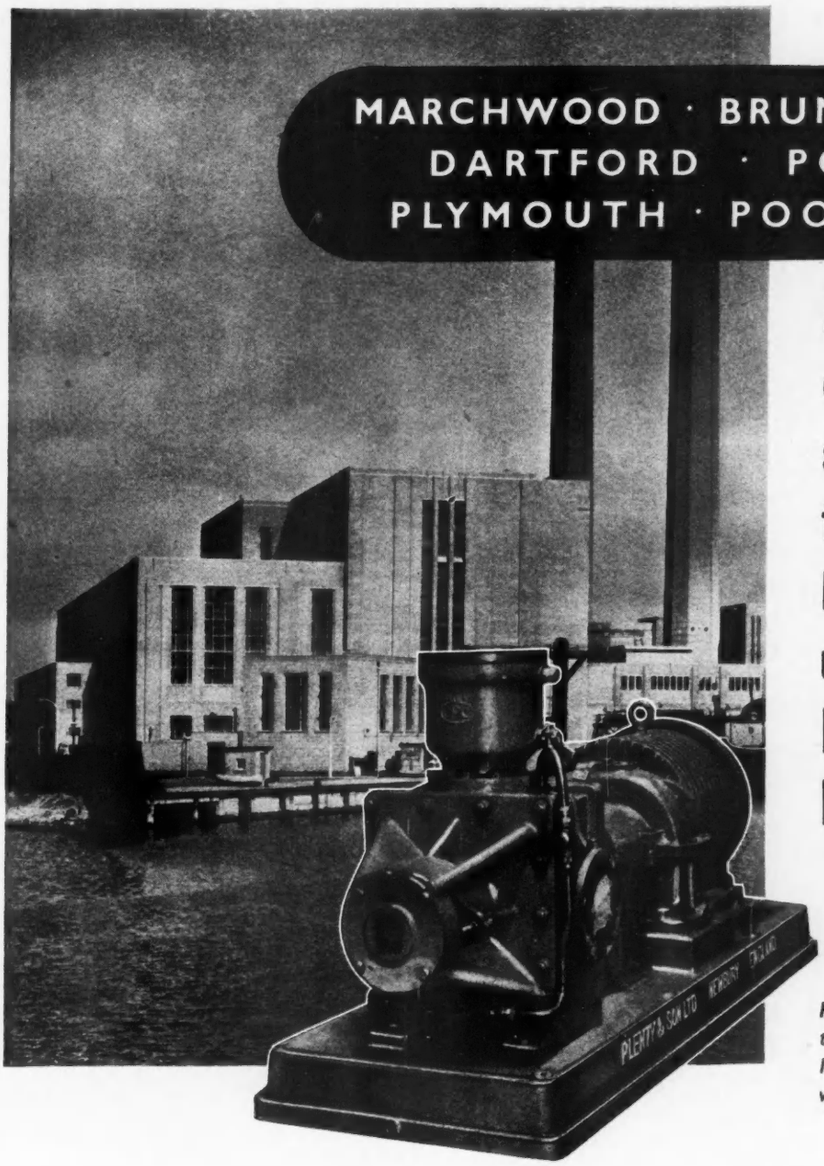

All these major oil fired power stations of the Central Electricity Board use PLENTY PUMPS

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No lubrication
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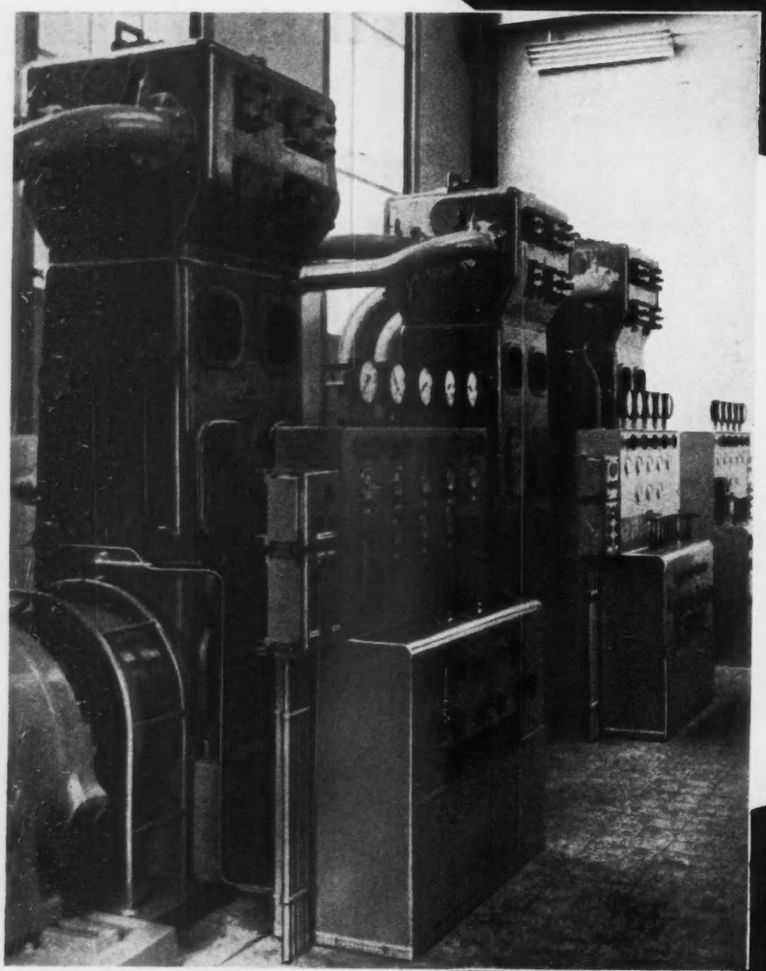

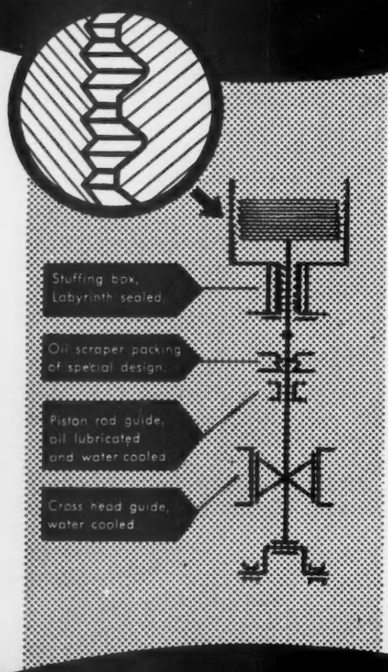
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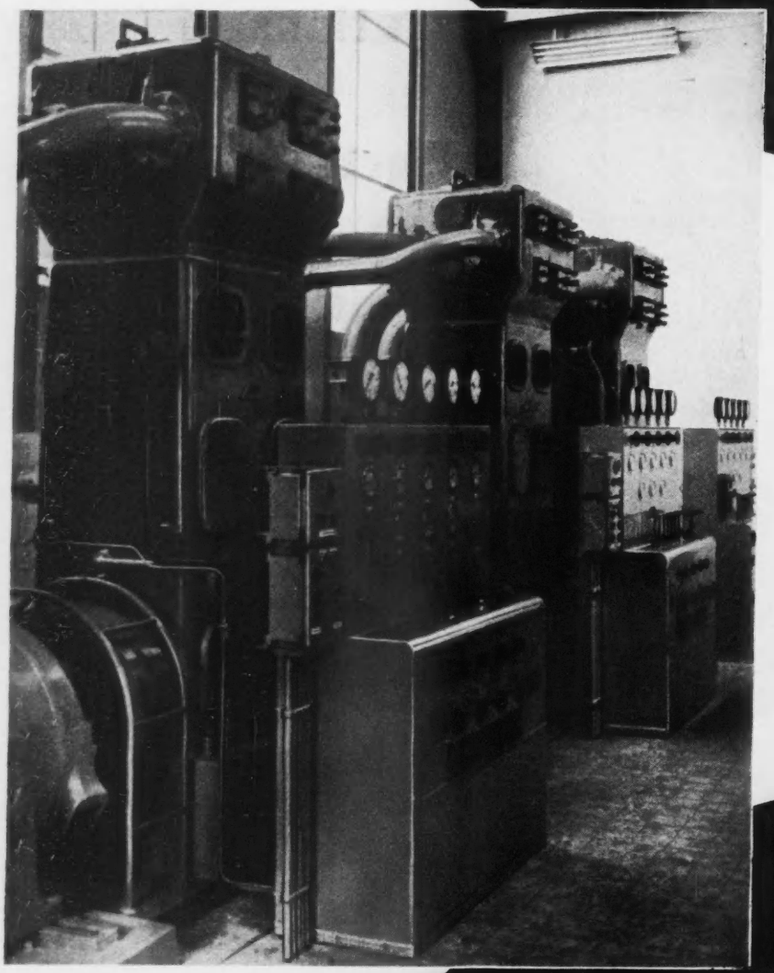

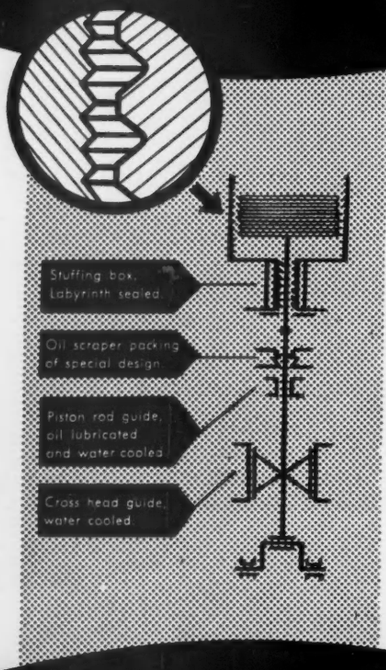
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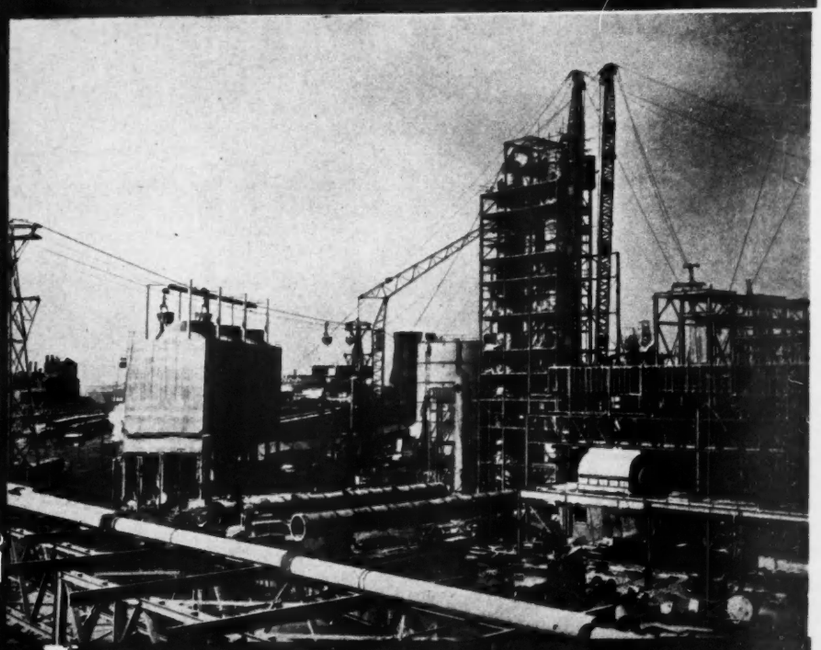

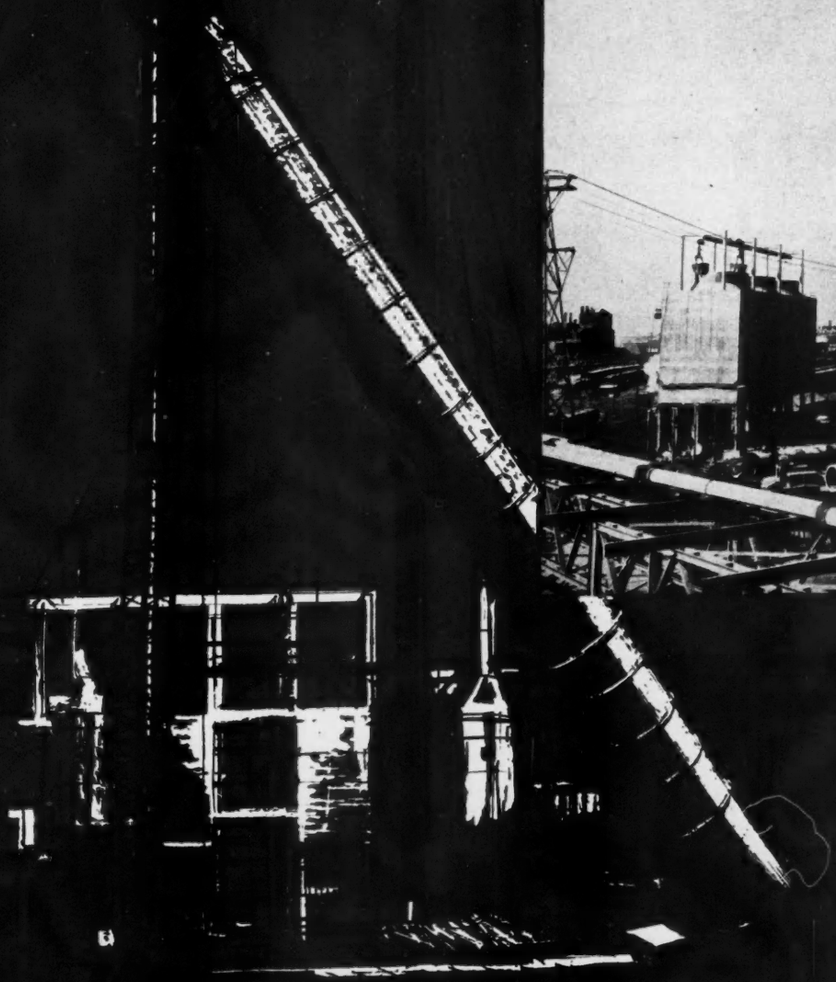

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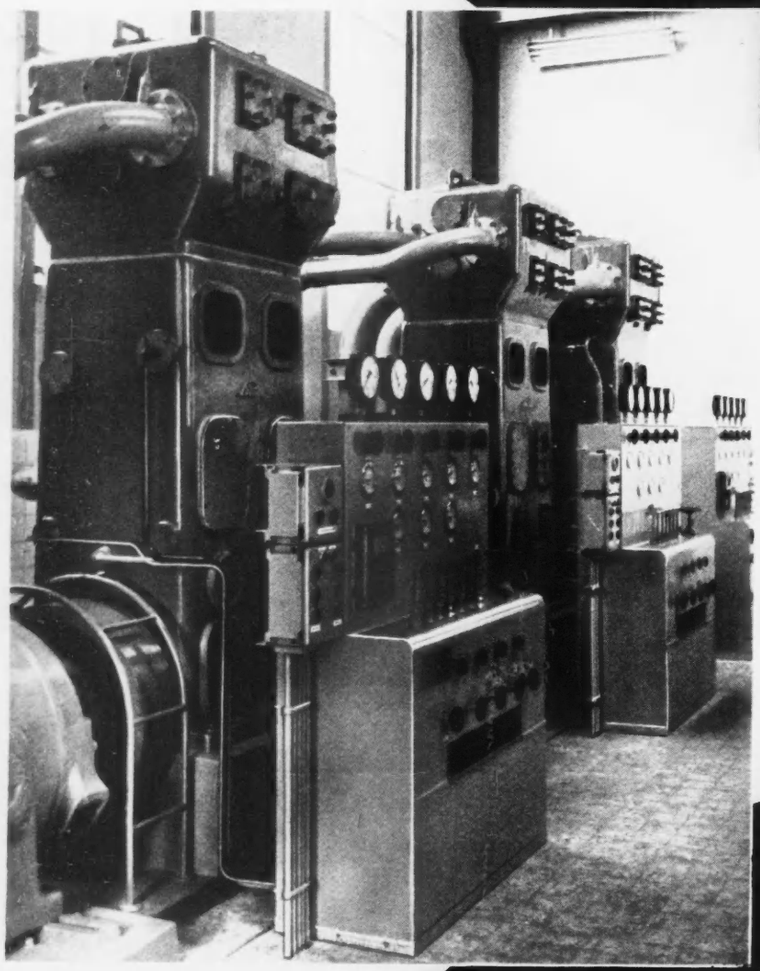

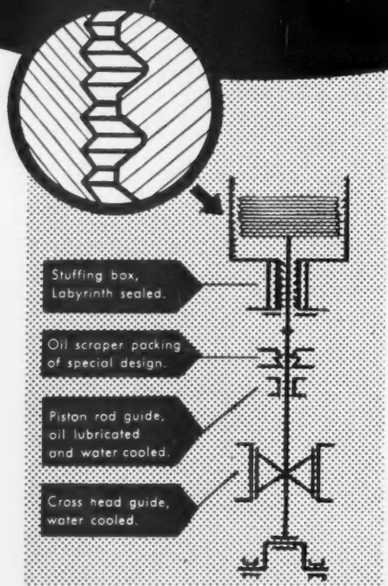
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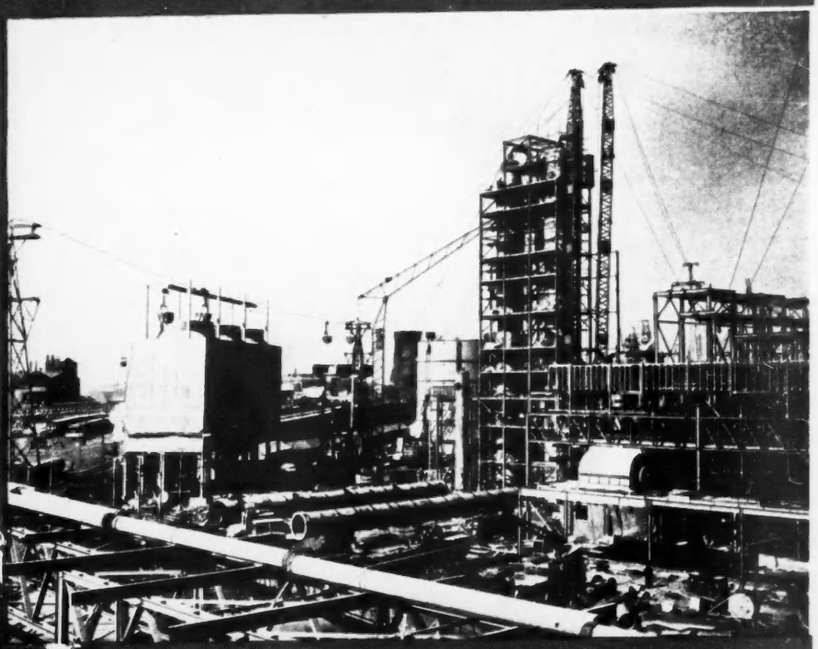

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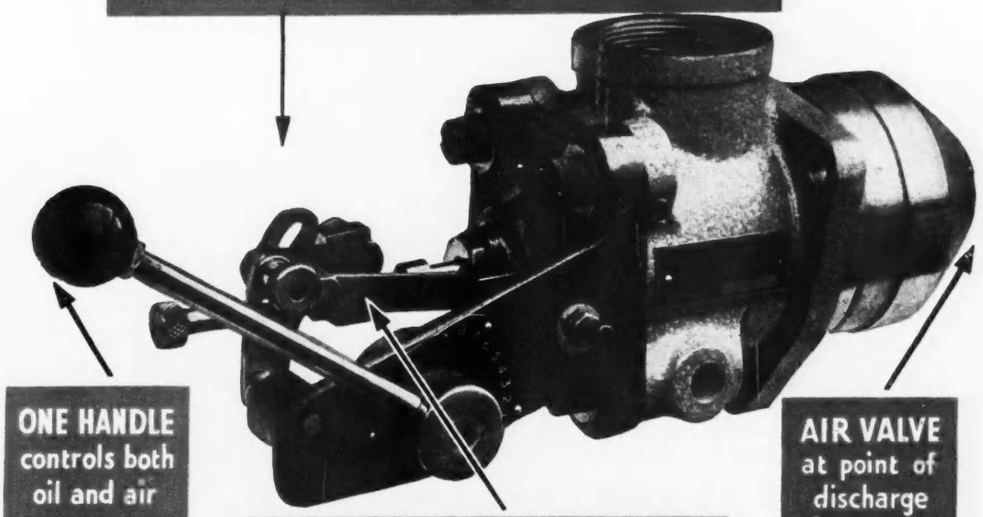

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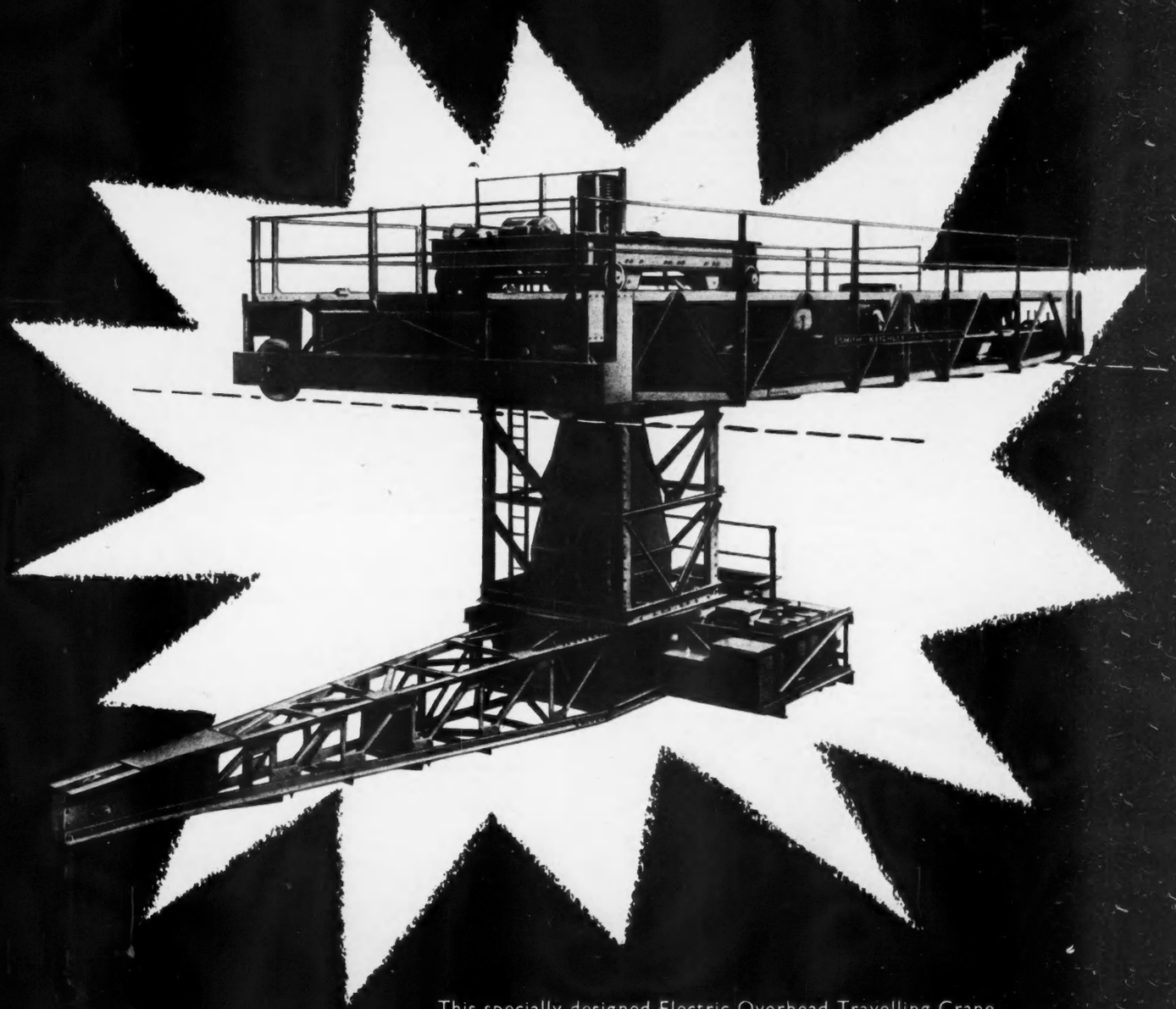

This specially designed Electric Overhead Travelling Crane has an Underslung Jib revolving in a complete circle, thus giving maximum hook coverage over the floor area, and also enabling loads to be transferred to adjacent bays.

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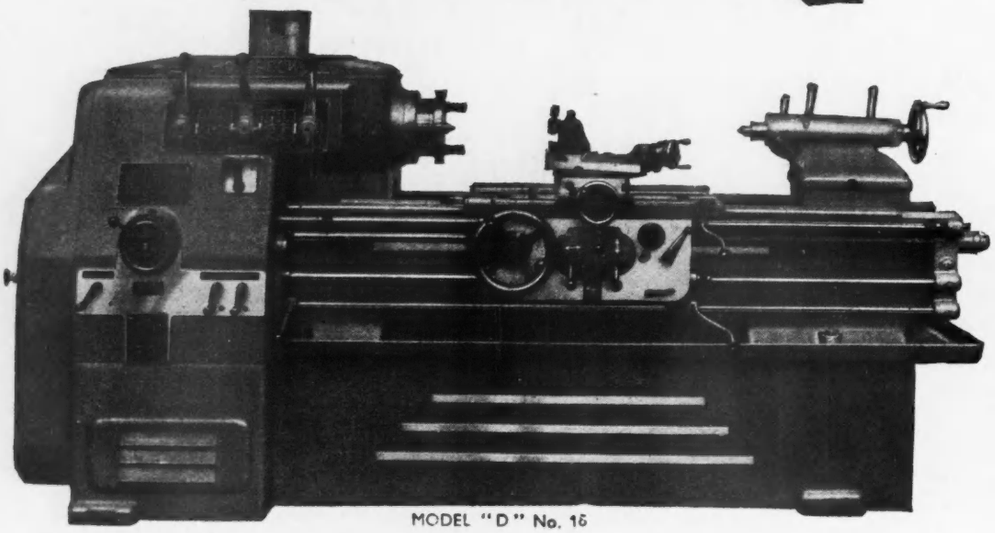

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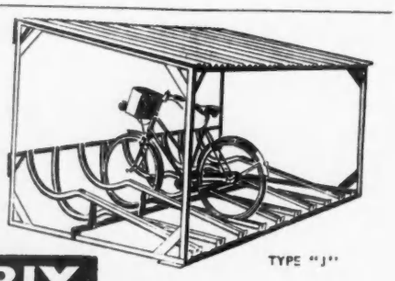

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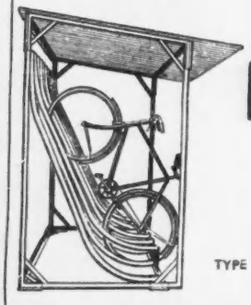

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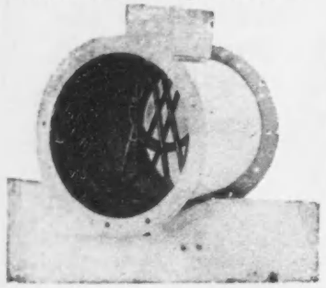

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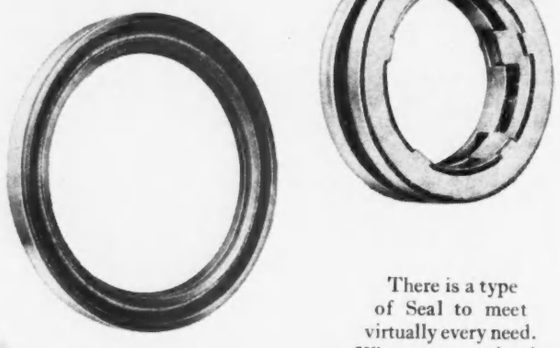

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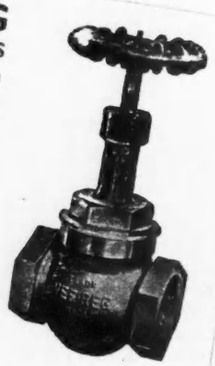

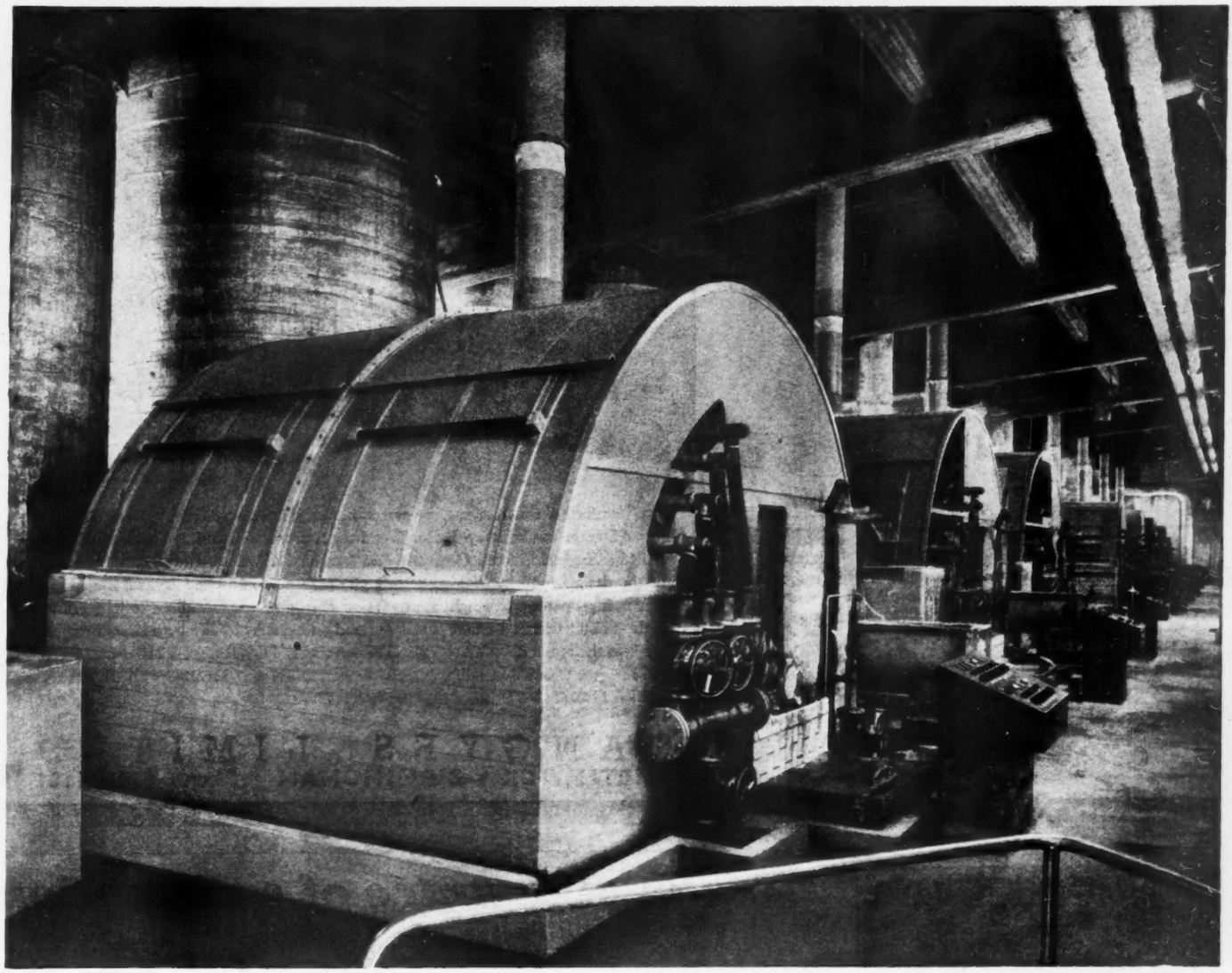

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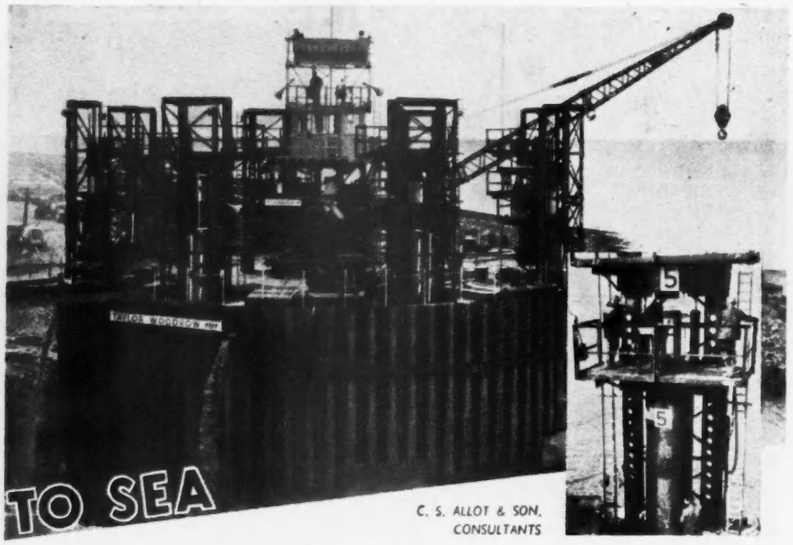

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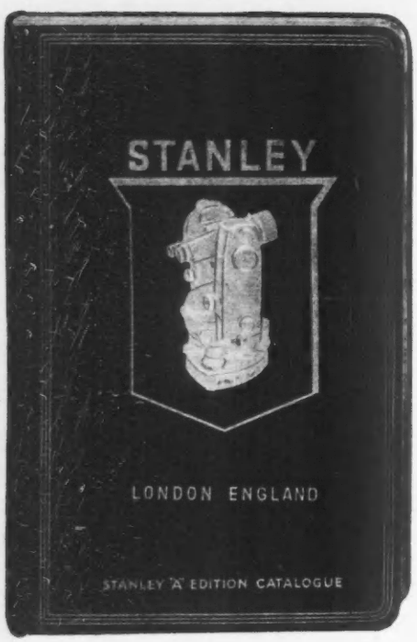

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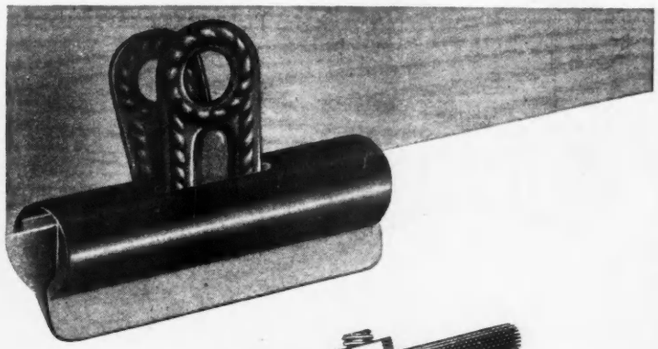
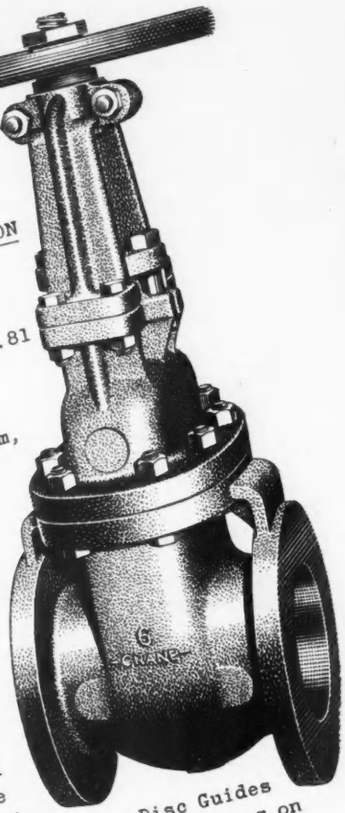


BULLETIN ON CRANE CAST IRON
WEDGE GATE VALVES

..featuring this time the F.81



Specification: Bronze trim, rising stem. Flanged British Standard Tables "D" and "E". Working pressures: saturated steam up to 100 pounds. Water or oil (cold, non-shock) up to 200 pounds. Besides the F.81. Crane, of course, make innumerable variants of this and other Cast Iron Gate Valves from 2" to 12". All have these features: long Disc Guides which seat Discs properly, minimise drag on seat faces, and prolong valve life. Shoulder type Seat Rings prevent rings from loosening. Two piece Ball-Type Gland prevents binding on stem—even when gland bolt nuts are pulled up unevenly. All are available in bronze trim or all-iron—with screwed or flanged ends (according to size)—with rising or non-rising stem. According to trim they are suitable for use with steam, water oil or gas services.

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V.14

There's talk of Sykes down under

Some time ago a Commonwealth visitor to Britain heard about Sykes' reputation for solving problems of gear production. This man's business was agricultural equipment, and he believed there was a good market in his country for a power 'take-off' unit, which could operate equipment such as milking and ditching machines, water pumps, power clippers, etc. But although he could visualize the mechanics of his invention he was uncertain about some of the technical details of the gearing involved.

He found this was the kind of problem Sykes take easily in their stride. Years of work at their main business of supplying first-class generating machines and equipment—hobbers, shavers, shapers, and cutters—has given them an unequalled store of expert knowledge and experience in this field. And through their Technical Sales Advisory Service this accumulated knowledge is available to everyone who comes to Sykes for service.

Thus this important Commonwealth visitor soon found the technical advice he had been looking for. Now, on the other side of the world, he has a factory producing power 'take-off' units—an enterprise which might never have been realized had he not initially come to Sykes for technical advice. Sykes had not only designed the gears, but also advised on the most efficient and economical production methods and schedules.

Talk to SYKES about gear production

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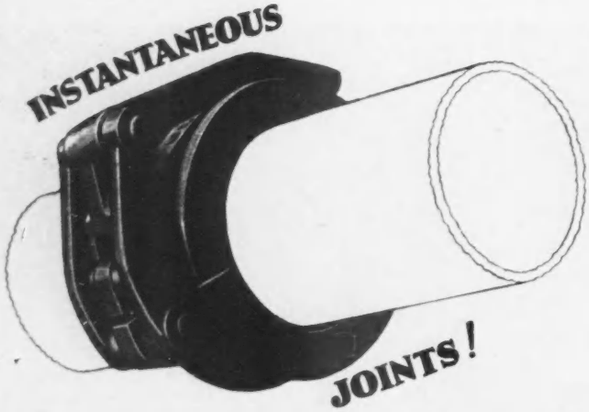

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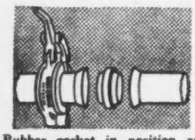
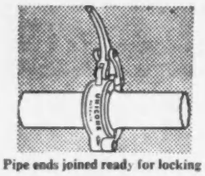
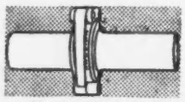

Rubber gasket in position and joint ready to pull over.


Pipe ends joined ready for locking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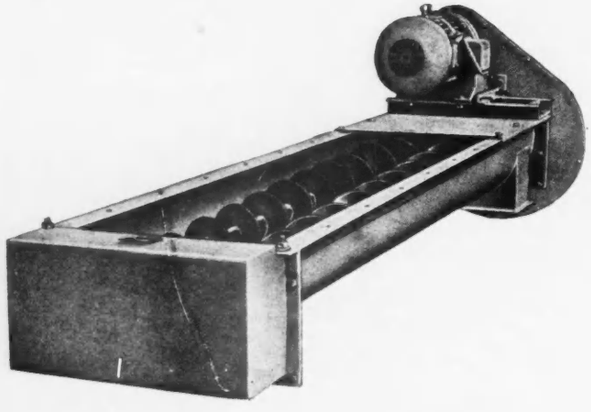

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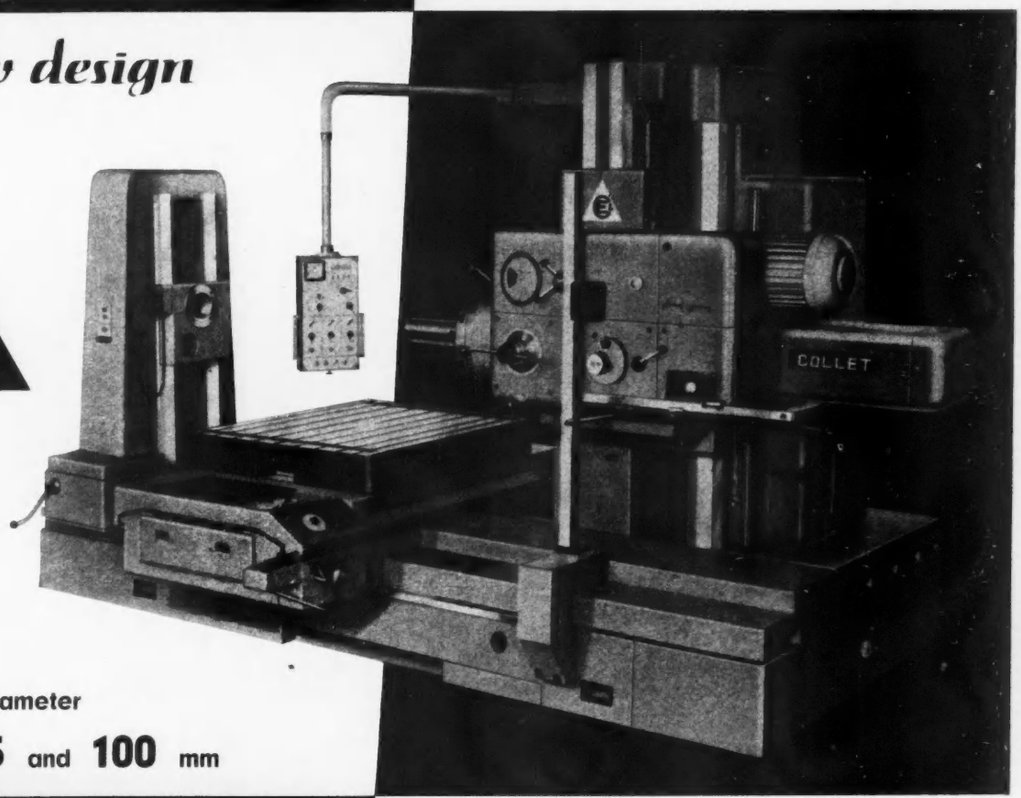

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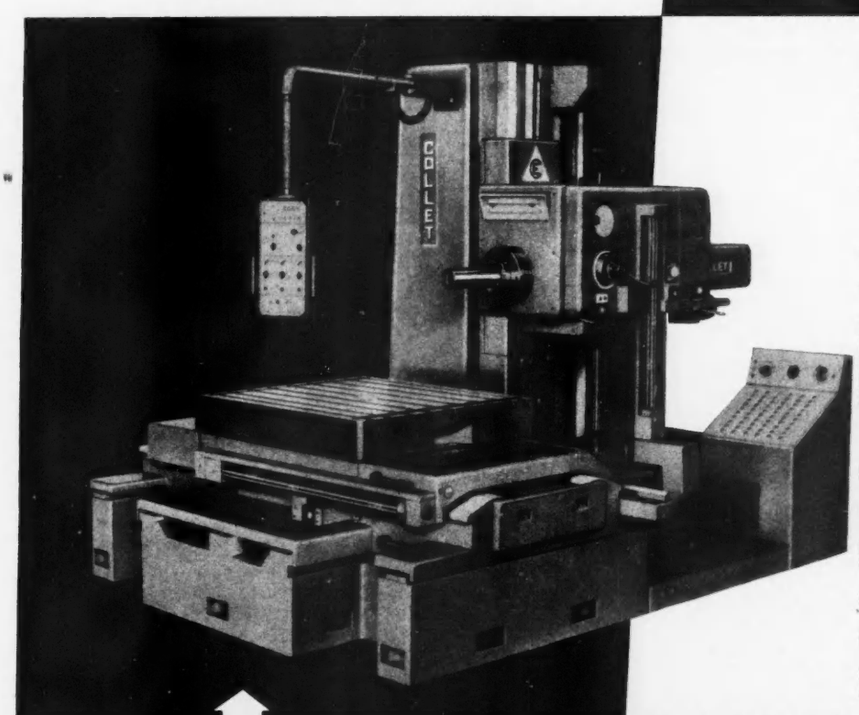

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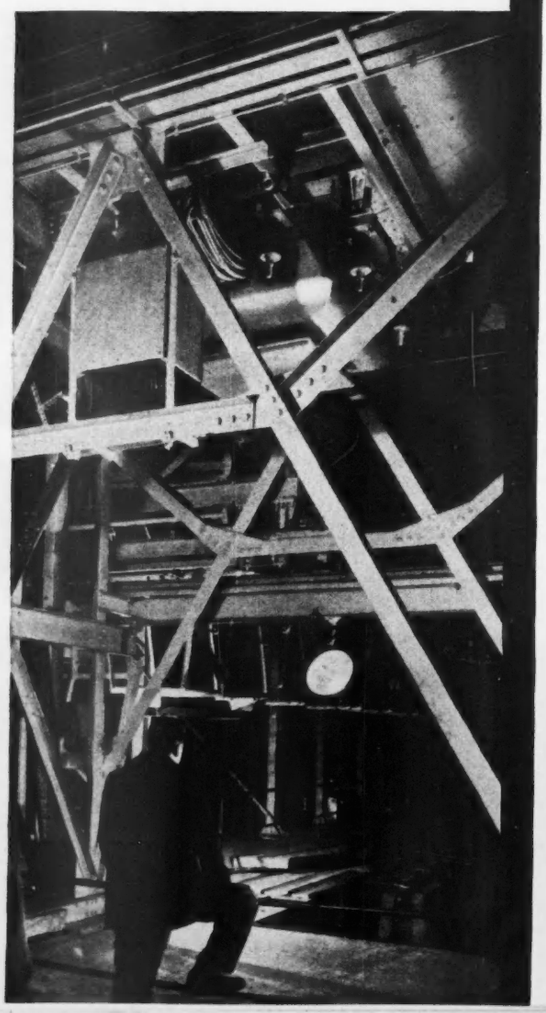
The silicone rubber insulated cables are installed above the quench tank (shown at the right) in which aluminium slabs are lowered after they have been taken from the furnace.

(Photograph by courtesy of Northern Aluminium Co Ltd)



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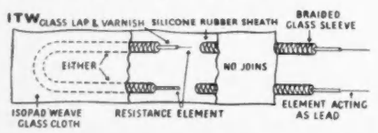
Isopad Ltd specify Silastomer silicone rubber for covering their flexible heating tapes designed for operation at temperatures of up to 200°C in moist conditions. And for good reason. Silastomer retains its flexibility and excellent dielectric properties over an extremely wide temperature range—from −100°C to +250°C.

No organic rubber can match this performance and that is why Silastomer is specified by Isopad and many other manufacturers for all types of equipment and appliances where reliability is essential—from seals in domestic irons to resilient diaphragms in valves.



Isotape tape ITW showing the heating elements covered with Silastomer silicone rubber. This weatherproofs the Isotape and makes it suitable for a temperature range of –100°C to 222°C.

*Silastomer is a registered trade mark of Midland Silicones Ltd.

Isotapes being fitted to bitumen feed pipes

(Photograph by courtesy of Isopad Ltd)

MS

Silicone greases remain serviceable from −70°C to +230°C

London Transport were experiencing considerable difficulty during cold weather due to the sticking of unloader valves on the compressors of their Green Line buses. An MS silicone grease solved the problem. Because of their outstanding resistance to extremes of temperature, MS silicone greases remain serviceable over a far wider temperature range than organic lubricants, thus providing reliability in operation and a reduction in maintenance costs. An MS silicone grease or lubricant may offer the most practical and economical solution to your most difficult lubricating problem.

The photograph shows the unloader valve fitted to Green Line buses. Courtesy of London Transport Executive.

Write for full information about these and the many other silicone products with applications in the engineering industry including release agents, damping and hydraulic fluids, heat-resistant paint resins, lubricants and electrical insulants.

MIDLAND SILICONES LTD
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Tel: Knightsbridge 7801
Area Sales Offices: Birmingham · Glasgow · Leeds · London
Manchester · *Agents in many countries*

First in British Silicones

MS

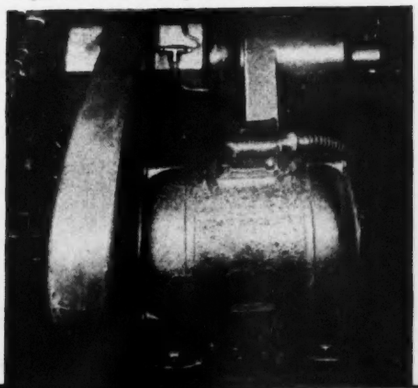
Silicone-insulated motors withstand years of continual 'plugging'

The photograph shows a silicone-insulated motor operating at the Stonehouse Works of Hoffman, Gloucester Ltd, who have kindly provided us with the following information—"We have a bank of 12 machines, each being driven by a 2 h.p. 1425 r.p.m. motor and as the motors have burnt out they have been rewound with silicone insulation, by British Electrical Repairs Ltd, and this has proved very satisfactory over the past 2/3 years.

"These motors are working in unusual conditions, as the following description of their working cycle shows, and they stand up to the work very well indeed.

"A complete operation takes 12 seconds then the machine is operated to reload which takes 2 seconds. To decelerate rapidly to the stop position for loading the operator presses the stop button followed by 'plugging' (pressing the reverse button). This is drastic treatment when continued all day and speaks well for the rewound motors".

This is a typical example of how MS silicone insulation increases the life and reliability of hard-working motors . . . saves money by reducing the need for frequent rewinds and replacements.



MS

Silicone fluids speed production at Mullards

An MS silicone fluid is used in the SPEEDIVAC* vacuum diffusion pumps which serve each plant of this rotary machine for producing Radiant Screen television tubes at the Mullard Television Tube plant at Simonstone. Because of the excellent heat stability and oxidation resistance of the silicone fluids, cooling of the pumps before releasing the vacuum is not necessary. Rapid cycling is therefore possible resulting in more efficient production.

*Trade name of Edwards High Vacuum Ltd

Because of their versatility MS silicone fluids overcome many of the limitations of organic fluids and open the way to improvements in the design of equipment and in production techniques. Advantages include:

* Serviceable temperature range from −100° to 450°F
* Available in viscosities from 0.65 to 1,000,000 centistokes
* High flash points
* Low vapour pressure
* Excellent oxidation resistance
* Low coefficient of expansion
* High degree of compressibility

Write for Silicone Notes G11 which details many of the applications of MS fluids.

(*Photograph by courtesy of Mullard Limited*)

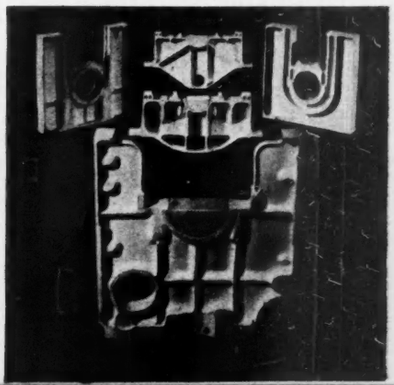
MS

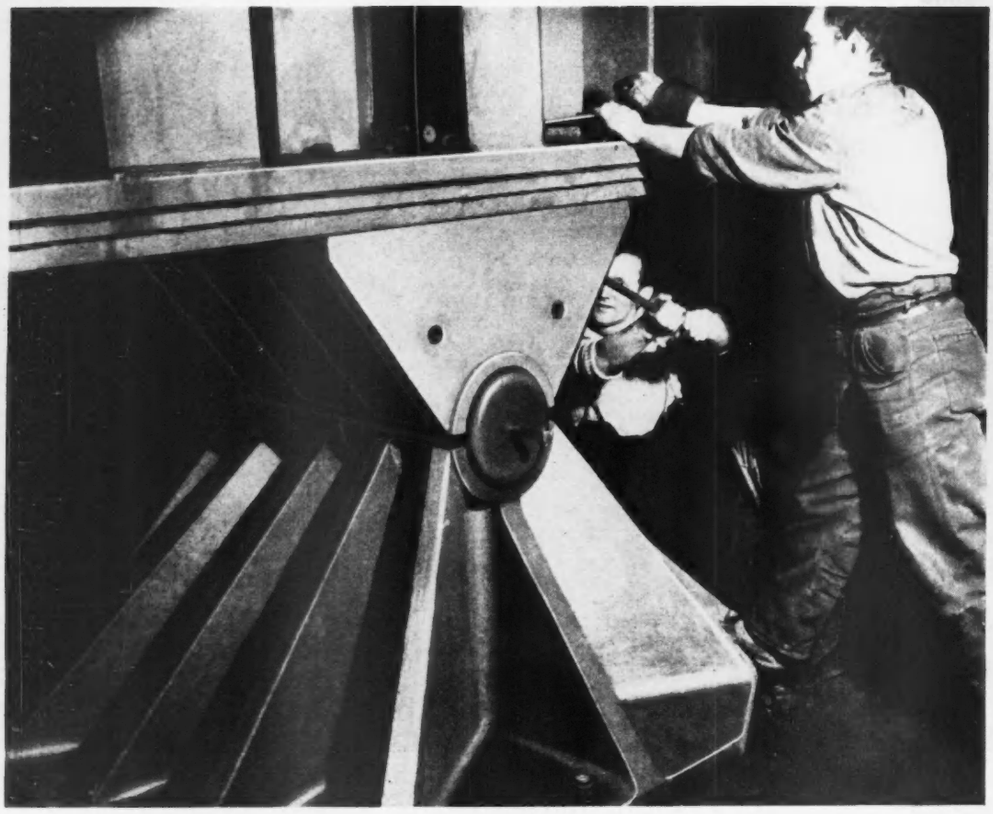
Cold-Cure Silastomer* aids diesel design research

Cold-Cure Silastomer—the silicone rubber that needs no heat to cure—is used for making scale models of diesel engine components to enable their behaviour to be studied under different simulated loads.
Wooden moulds are made, assembled and painted with a release agent and the Cold-Cure Silastomer is poured in and left to set. No special equipment is needed and the models are ready for use in about 24 hours after casting at room temperature.
Cold-Cure Silastomer is remarkably versatile and opens up new fields for designers. The addition of a catalyst is all that is required to cure at room temperature and the material possesses the excellent dielectric properties, heat endurance and high thermal conductivity associated with silicone rubbers.
Cold-Cure Silastomer can be used by unskilled operators to fill voids round lead wires of coils and motors, for impregnating coils, and for other similar sealing or potting applications. It can also be used for making flexible moulds in which epoxide resins are cast.
Write for a sample—on your company letterhead please—of either Cold-Cure Silastomer 9160 or 9161. The former has a spreadable consistency and the latter is suitable for dipping. Silicone Notes K28 is also available listing the properties and applications.

*Silastomer is a registered trade mark of Midland Silicones Ltd

(*Photograph by courtesy of Ruston & Hornsby Ltd*)





RTB

LEFT:
The master support for the new Dan-y-Graig Railway Bridge.

S.G. IRON CASTINGS FOR STRUCTURES

The Dan-y-Graig Railway Bridge, designed and being erected by British Railways Western Region on the by-pass at Swansea, eliminates two dangerous bottlenecks.

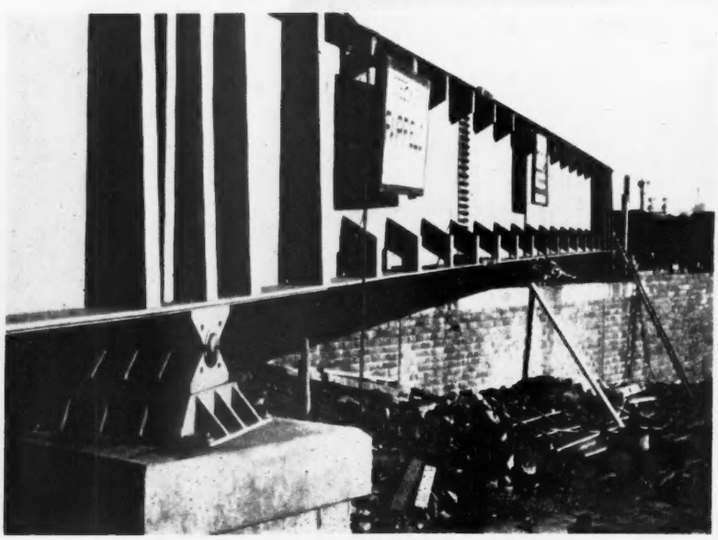
The new steel superstructure, fabricated by Fairfield Shipbuilding & Engineering Co. Ltd. of Chepstow, is supported at nine points: at one there is a pivoted master support controlling the position of the whole bridge; the other eight supports can pivot and slide to allow for expansion.

These castings, of special S.G. iron, came from the R.T.B. foundry at Machynys, completely machined and ready for erection.

Our foundries and engineering works in South Wales produce all types of ferrous castings up to 10 tons (iron castings up to 30 tons in certain cases) and non-ferrous castings up to 1 ton. We have well equipped shops for steel fabrication, constructional and general engineering work.

BELOW:
The new bridge, showing one of the eight slipper block supports.

Photographs reproduced by permission of Mr. M. G. R. Smith, Chief Civil Engineer, British Railways Western Region.



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Sales Dept., FOUNDRY AND ENGINEERING PRODUCTS
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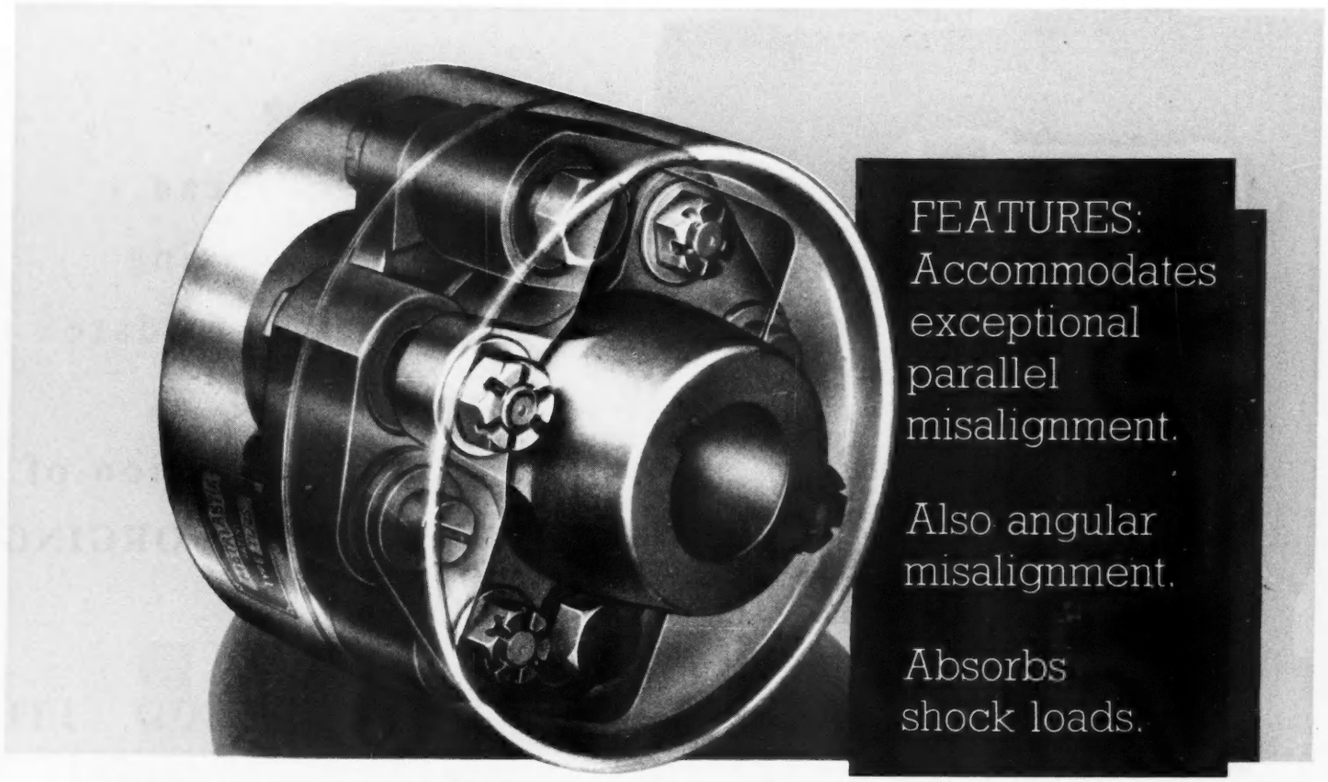


The trailing-link coupling

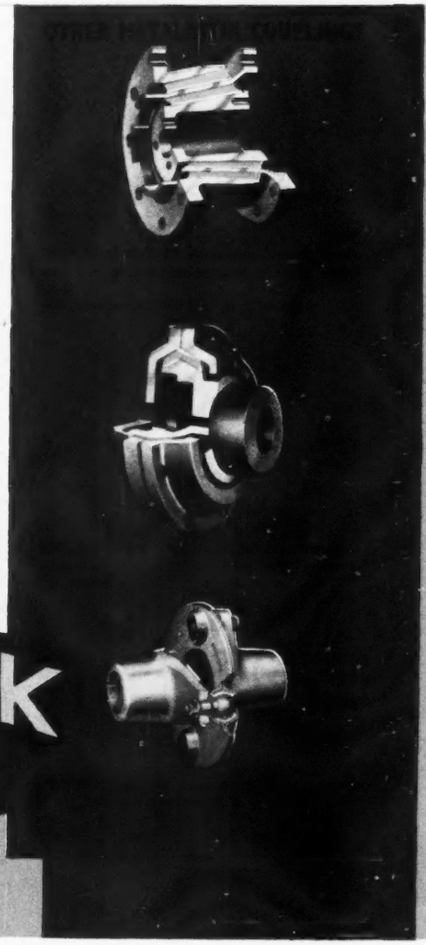
Compactly designed to accommodate substantial parallel and angular misalignment while transmitting power without loss of efficiency (less than 0·1%), Trailing-Link Couplings are available in a range of sizes for drives of 1—20 h.p. per 100 r.p.m.

They provide for end-float, absorb torsional vibration and smooth out shock loads.

The Trailing-Link Coupling obviates the need for a cardan shaft and universal joints and its capacity for accommodating parallel misalignment is unequalled by any other flexible coupling of comparable size and rating.

Trailing-Link Couplings need no lubrication or servicing and their functioning is unaffected by dust, grit or moisture. They are in consequence ideally suited for working under all conditions.

The advice of our very experienced engineers is at your service.



METALASTIK

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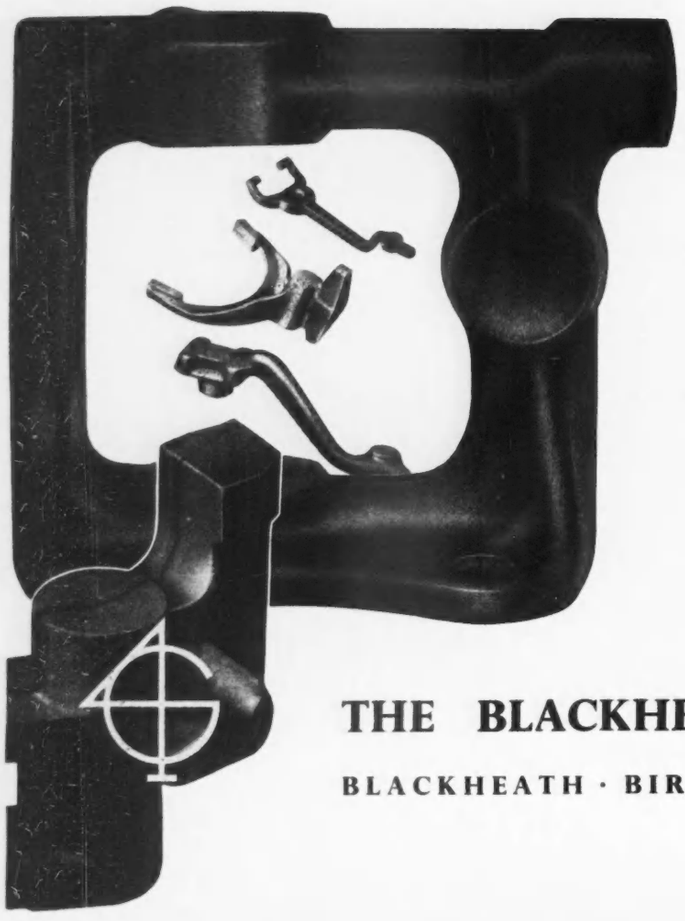
M 252



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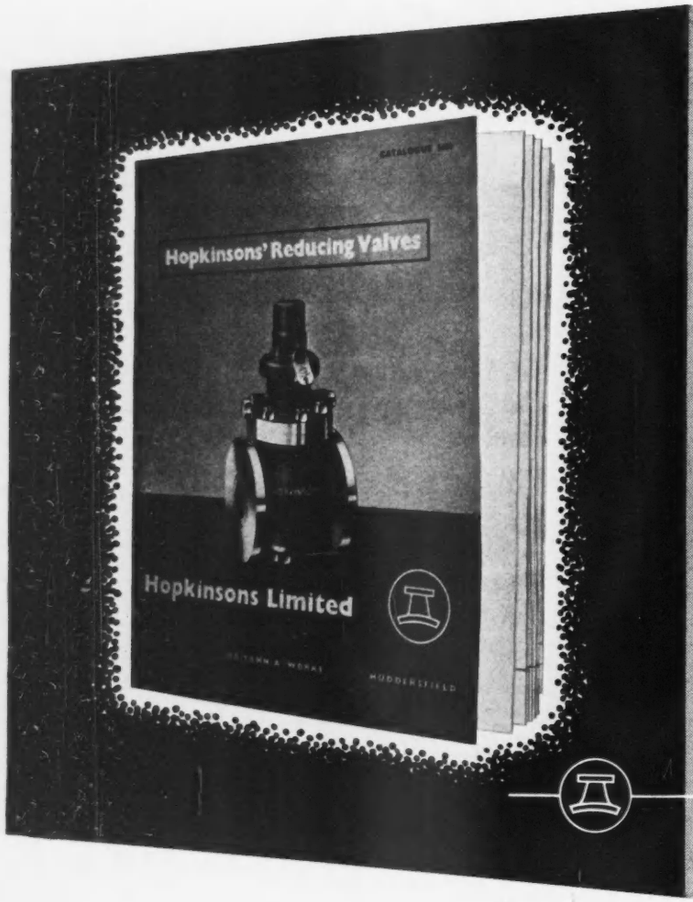

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The conditions governing the use of reducing valves may run from relatively simple valves for the steam pressures encountered in canteen kitchens, hotels and institutions, to the exacting duties of back-pressure turbine control or for dealing with high pressure, high temperature steam.

Hopkinsons have a type of Reducing Valve suitable for every duty; full particulars of their characteristics and suitability to different applications are contained in Catalogue 5600.

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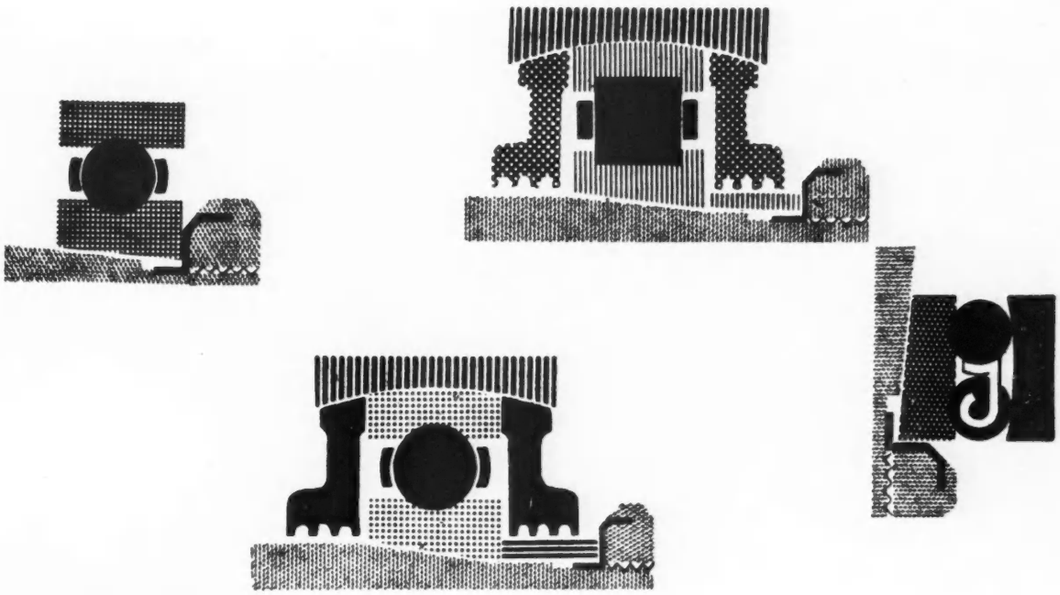

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R⅛M ADAPTER SLEEVE BEARINGS BRING YOU THESE BENEFITS

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- **Side plates provide built-in grease retention seals.**
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Have you a copy of our Publication 37? Full technical details of Adapter Sleeve Bearings will be found on page 98.

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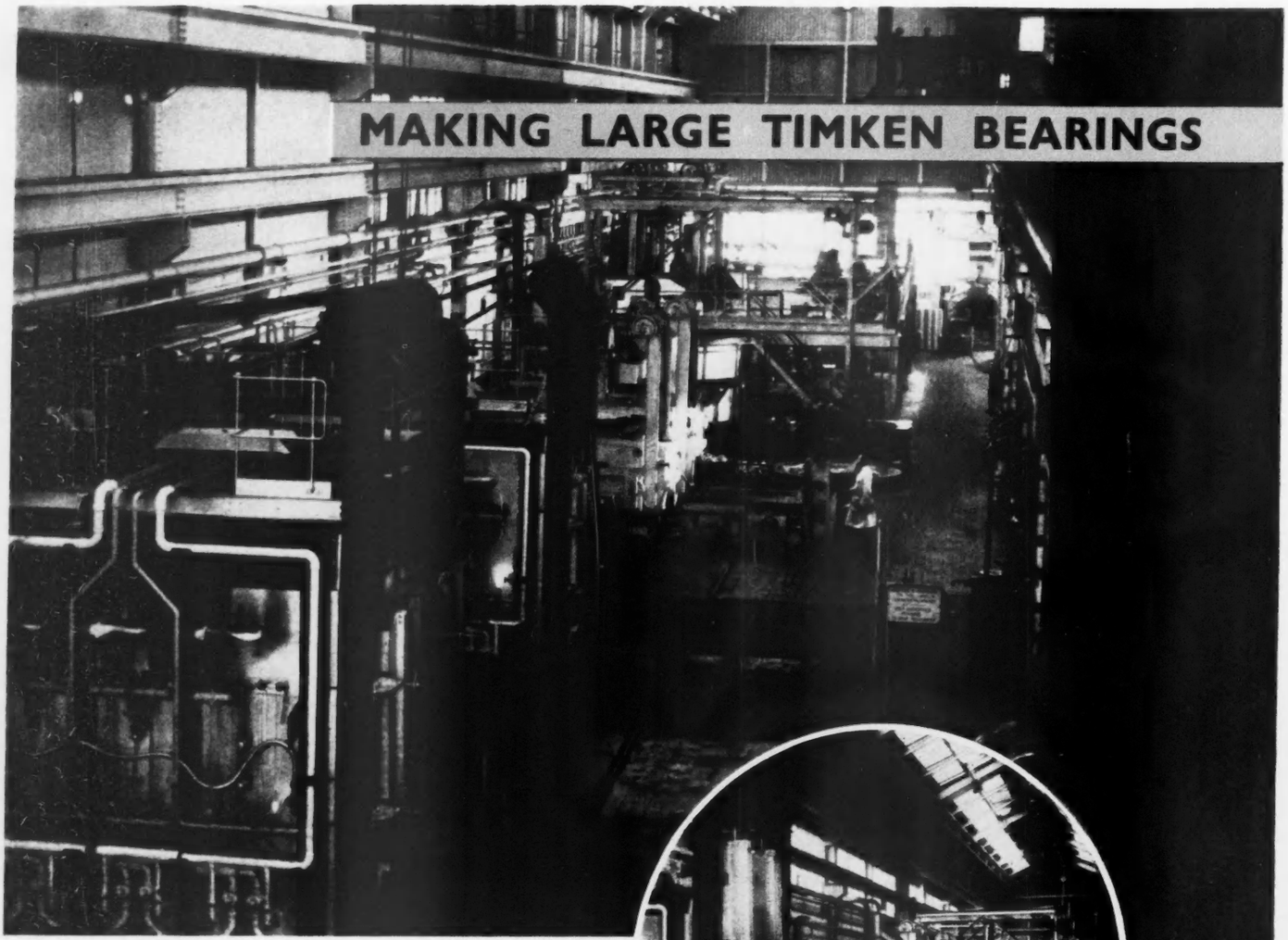
MAKING LARGE TIMKEN BEARINGS



THE high performance given by Timken tapered-roller bearings is due to the use of the finest case-hardening nickel-alloy steel, coupled with carefully controlled heat-treatment and high precision workmanship.

The heat-treatment processes produce a hard, wear-resistant surface of great durability, with a resilient, shock-resistant toughened core.

This is a view of part of the heat treatment department, and the inset illustration shows a large double outer race being removed from the furnace prior to quenching.

TIMKEN REGD TRADE MARK

TAPERED-ROLLER BEARINGS MADE IN ENGLAND BY

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Morrisflex 300

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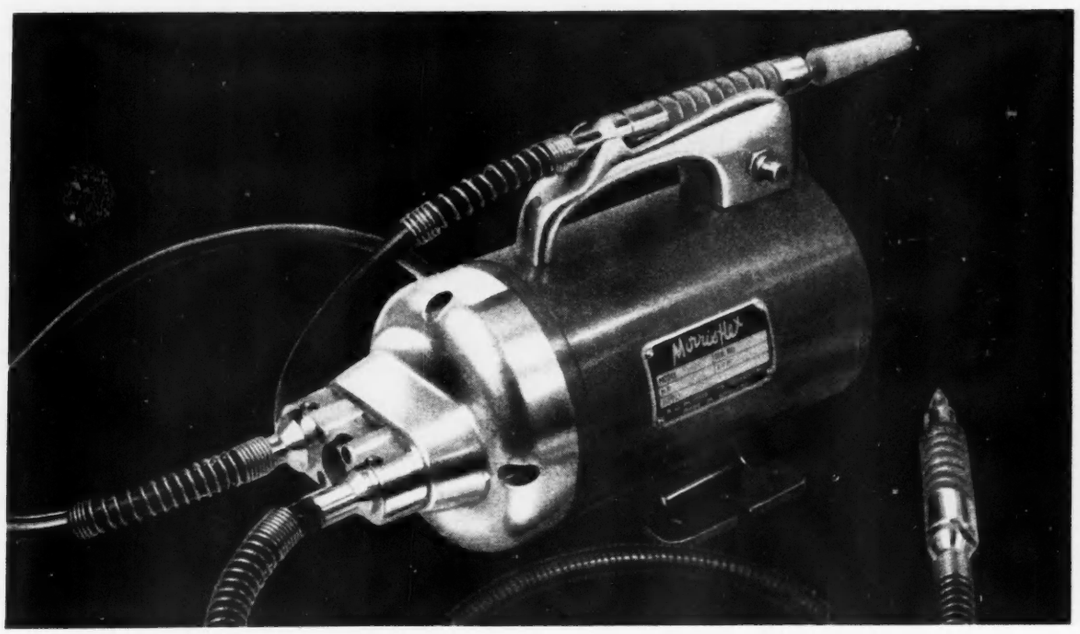

QUICKER SPEED CHANGE
LIGHTER TO HANDLE
EASIER TO MANOEUVRE
FINER FINISH OBTAINED

The M300 is an entirely new machine specially designed for use in the tool room and in all cases where finish is of paramount importance. Optimum speeds are available for cutters in steel or carbide.

Details from

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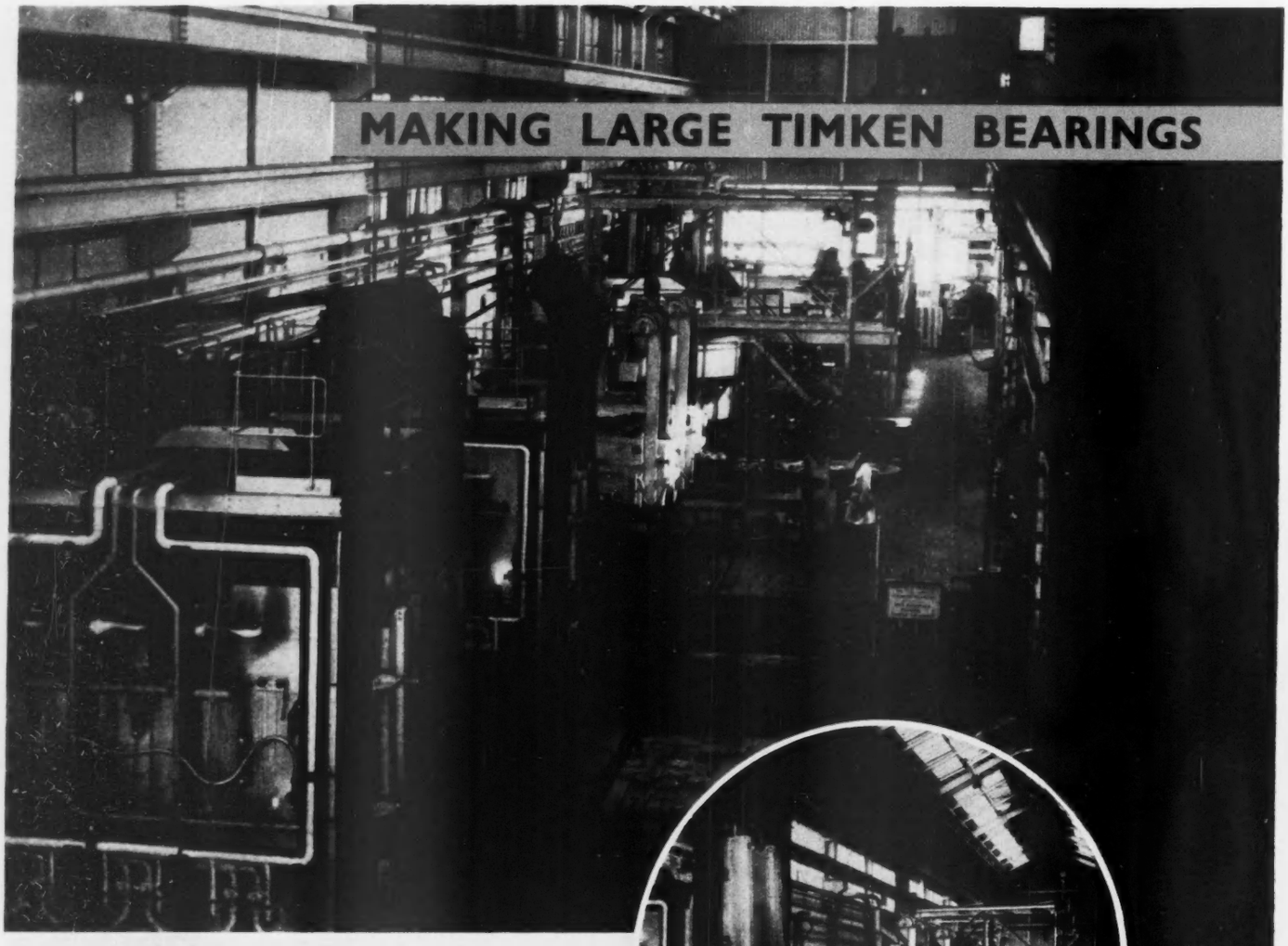

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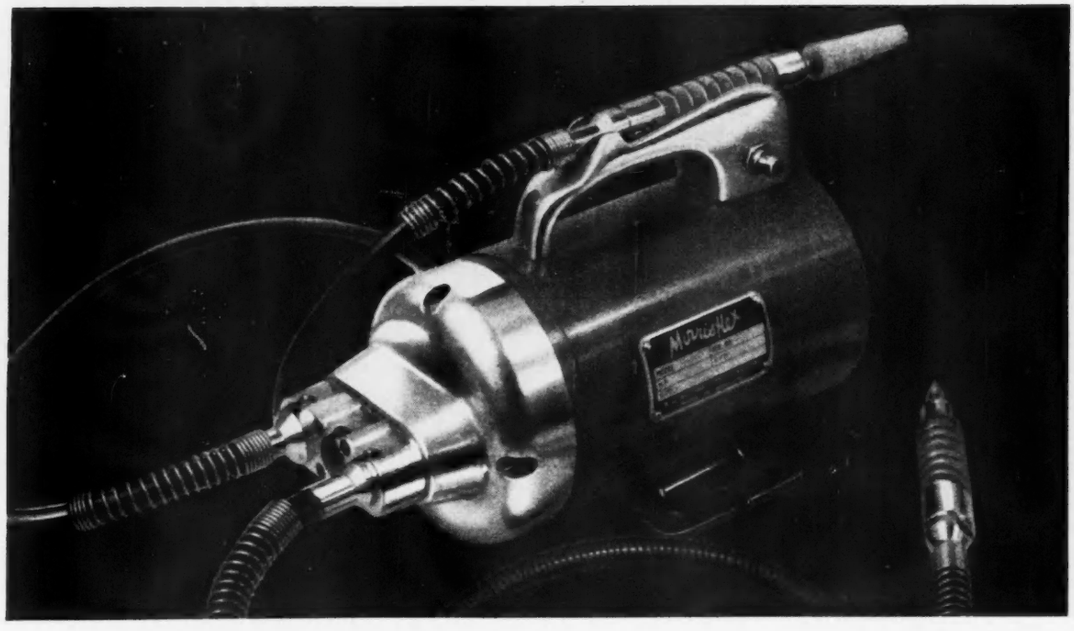

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Fig. 1
A front view of the gas-heated annealing furnace at Langley Alloys Ltd. showing the furnace construction and the hearth part withdrawn towards a sunken quench tank.

Fuel Selection for Annealing Castings

"replacing an existing furnace by one using town gas due to the high maintenance and replacement costs incurred with existing equipment".

Langley Alloys Ltd., manufacturers of the well-known "Langalloy" and "Hidurax" alloys, face a problem common to most heat treatment process users in that they need a flexible plant to treat loads varying in size and metallic composition.

For example, a recently installed furnace at Langley Alloys Ltd. is used primarily for the heat treatment of corrosion resistant castings in the "Langalloy" series of nickel-based and stainless steel alloys, yet it had to be satisfactory for hardening and tempering large forgings in aluminium, bronze and other copper-based alloys.

The nickel-based alloy castings include nickel-molybdenum-iron and nickel-chrome-molybdenum alloys which are solution heat treated by holding them at temperatures ranging from 1,150°C to 1,250°C followed by a water quench or air blast. This treatment ensures maximum corrosion resistance and eases the machineability.

Stainless steel castings include chromium steels and various grades of chromium-nickel austenitic steels, and the heat treatment is carried out at 950°C to 1,100°C, after which they are water quenched.

THE PROBLEM

The North Thames Gas Board Industrial Department was asked to collaborate in replacing an existing furnace by one using town gas due to the high maintenance and replacement costs incurred with the existing equipment. It was pointed out that the furnace hearth was subjected to hard wear caused by heavy parts being dropped on to it during loading. A bogie hearth furnace was suggested measuring 4 ft. 0 in. long by 3 ft. 0 in. wide. After the bogie hearth was withdrawn it had to be capable of being tilted so that the articles could be tipped into a side quenching tank. A maximum temperature of 1,250°C held within ±10°C was also stipulated.

A further requirement was a steel table used as a loading platform at the same height as the bogie hearth with a quenching tank sunk into the floor.

THE EQUIPMENT

The North Thames Gas Board discussed the requirement with the furnace manufacturers, and eventually a furnace was supplied and fitted to the following specification:

Dimensions of Furnace — Door opening 3 ft. 6 in. wide and 1 ft. 11 in. high from the top of the bogie to the spring of the door arch. Length from door face to back wall of 4 ft. 10½ in.

Wall and Arch Construction—Light-weight insulating refractory backed with diatomaceous insulation.

Casing—Totally enclosing the brickwork except the roof. Adequate in strength to prevent any distortion. Finished in heat resisting aluminium paint.

Bogie Construction—High quality firebrick top backed with insulating refractory. Door forming back of the bogie lined with light-weight insulating refractory and diatomaceous material. Sandseals on the sides and end of the car to prevent hot gases escaping from the furnace chamber. Wheel axles in roller

bearings for easy bogie movement. Hand wheel operated clamping screws on door to lock the bogie in position—the door protecting the operator against radiation as the bogie is withdrawn. Manual withdrawal by a chain and bevel gear drive to the wheels with operating handle at a convenient height on the back of the door. Sufficient rail length for withdrawal of the bogie clear of the mouth of the furnace for loading and unloading.

Gas Burner Equipment—Two air blast burner blocks firing from the rear wall on each side of the furnace. No flame impingement on the charge—the hot gases, after passing to the door, are drawn back through flues in the rear wall arranged at bogie hearth level. Flues connected to a common outlet with damper control.

Each burner set provided with graduated air and gas control cocks. A motorized valve, wired through a temperature control panel, simultaneously operates valves in the main air and gas supplies according to the heat input requirements.

Other controls on the main gas supply include a constant pressure governor, non-return valve and a solenoid operated main shut-off valve.

Air Supply—Fan blower at 22 in. w.g.

Loading Equipment—Mild steel loading table is provided with a top for easy loading of the work on to the bogie. As the hearth is at temperature all loading is carried out with tongs.

Unloading—A hand operated tilting device, the door again shielding the operator from the high temperature during bogie tilting. Locking device provided holding the bogie to the rails during this operation.

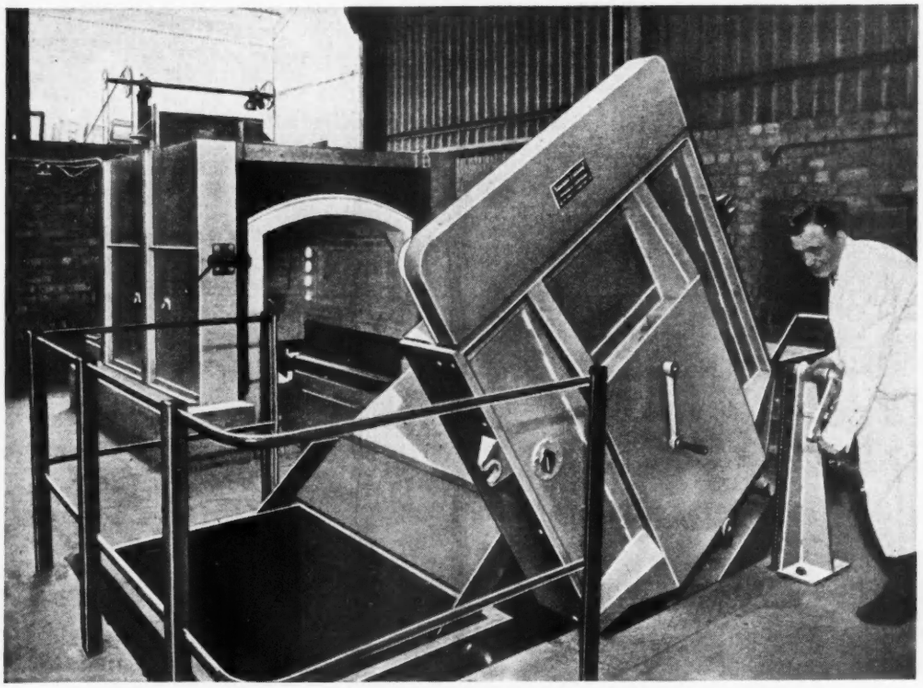
Quench Tank—Mild steel plates suitably braced. 3 ft. 0 in. wide by 4 ft. 6 in. deep by 5 ft. 0 in. long to quench 500 lb of castings with a water temperature rise to 140°F.

Safety Control—Diaphragm switches in both air and gas lines connected to solenoid valve in the main gas line. The solenoid valve closes with failure of gas or air supply and cannot be opened until it has been manually reset.

Test Results—Tests were made during a day's operation to determine the performance of the furnace under normal operating conditions. The working temperature of 1,050°C was obtained in 1¾ hours after lighting from cold for a gas consumption of approximately 12½ therms. The time to recover working temperature following loading was between a quarter and half an hour, depending upon the size of the charge.

One charge consisted of 291 lb. of small castings of nickel based stainless steel, and the working temperature was recovered in 20 minutes for a consumption of 2½ therms of gas. A further 4 therms were consumed whilst one hour's soaking was taking place, giving a total of 6½ therms for the treatment of the charge.

It is estimated that to heat the furnace and a 500 lb charge to 1,250°C would take 3 hours and require approximately 25½ therms of gas. For a follow-on charge of 500 lb, assuming the furnace to be at 1,350°C and the bogie at 1,000°C, would take 1 hour with a gas consumption of 11½ therms.



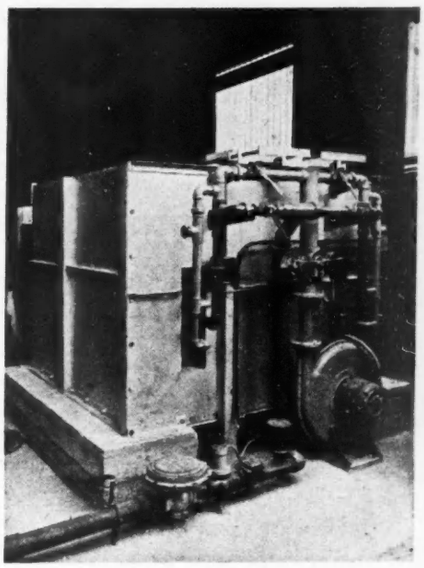


Fig. 2
A rear view of the annealing furnace showing the gas/air controls and safety devices.

This is one example of collaboration between the user and plant supplier where the North Thames Gas Board offered a free consulting service. An Industrial Gas Officer at any Area Gas Board can avail himself of the experience of his colleagues in other Gas Boards through the medium of the Gas Council's Industrial Gas Development Committee. And, of course, heat treatment is but one of the many trades, professions and occupations using the facilities and research of the British Gas Industry.

Fig. 3
A view showing the hearth completely withdrawn—the door protecting the operator from radiation from the charge—and being tilted towards the quenching tank.

. . .

Langley Alloys Limited also use town gas in their foundry for shell moulding, core drying, ladle drying and other specialised foundry requirements as well as for canteen and welfare purposes.

Scottish Gas Board, Edinburgh
Northern Gas Board, Newcastle-upon-Tyne
North Western Gas Board, Manchester
North Eastern Gas Board, Leeds
East Midlands Gas Board, Leicester
West Midlands Gas Board, Birmingham
Wales Gas Board, Cardiff
Eastern Gas Board, Watford
North Thames Gas Board, London, W.8
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The Gas Council, 1 Grosvenor Place, London, S.W.1

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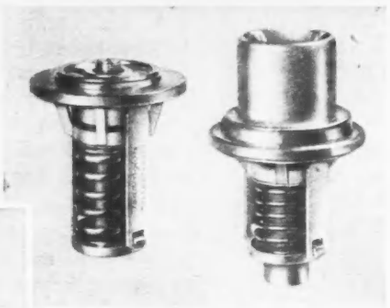
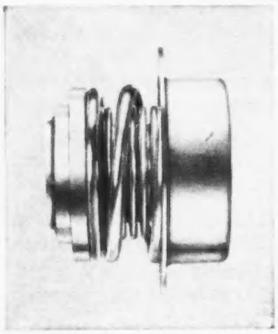
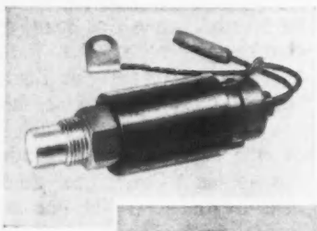
WAX-CHARGED COOLANT THERMOSTATS

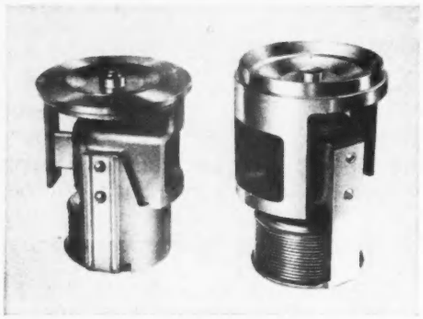




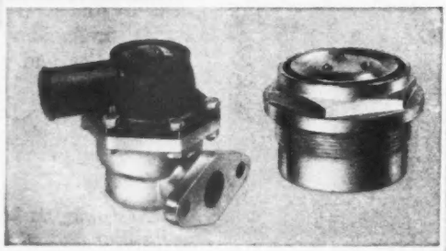
SHAFT SEALS

HEAVY DUTY TEMPERATURE AND PRESSURE SWITCHES

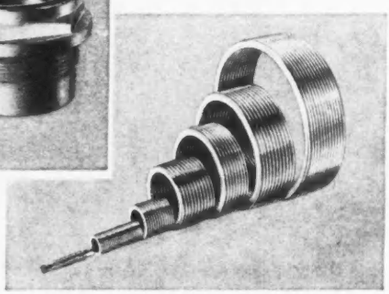




ENGINE COOLANT THERMOSTATS



PRESSURE RELIEF VALVES



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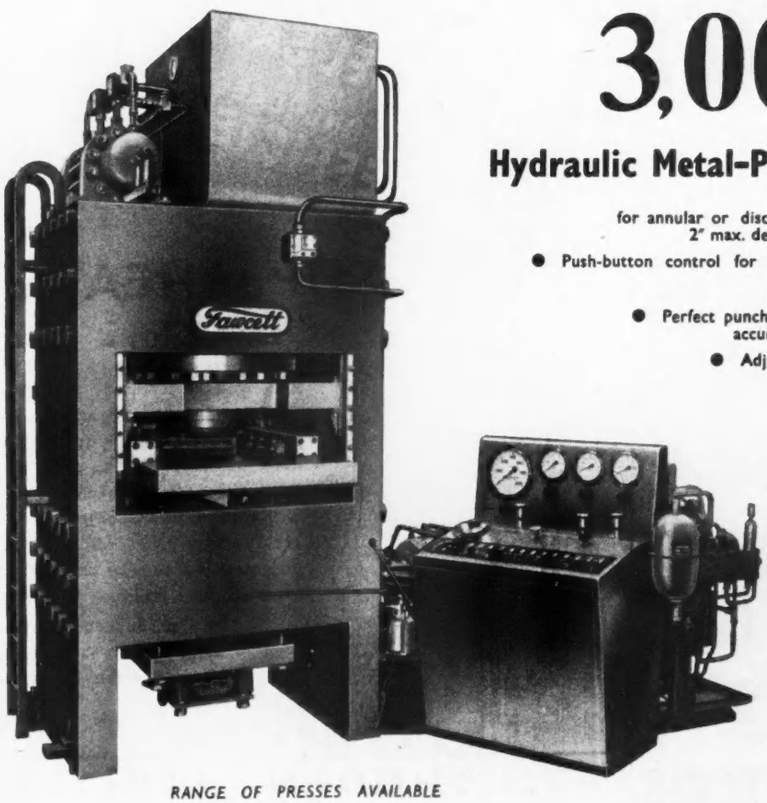

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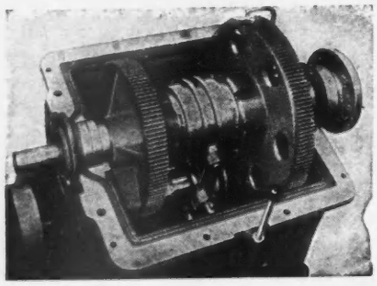

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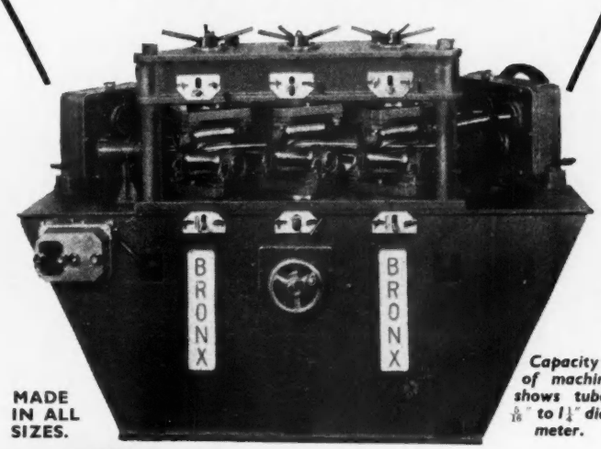

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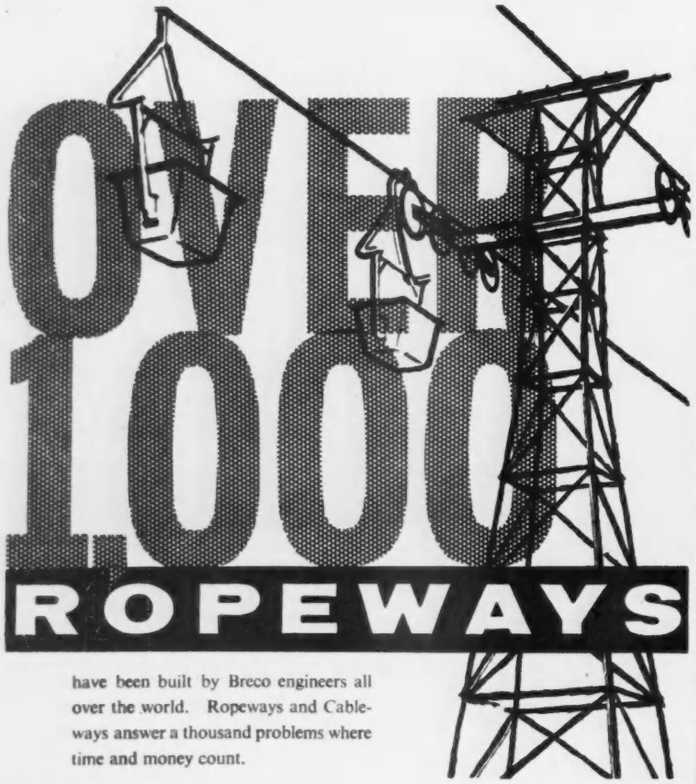

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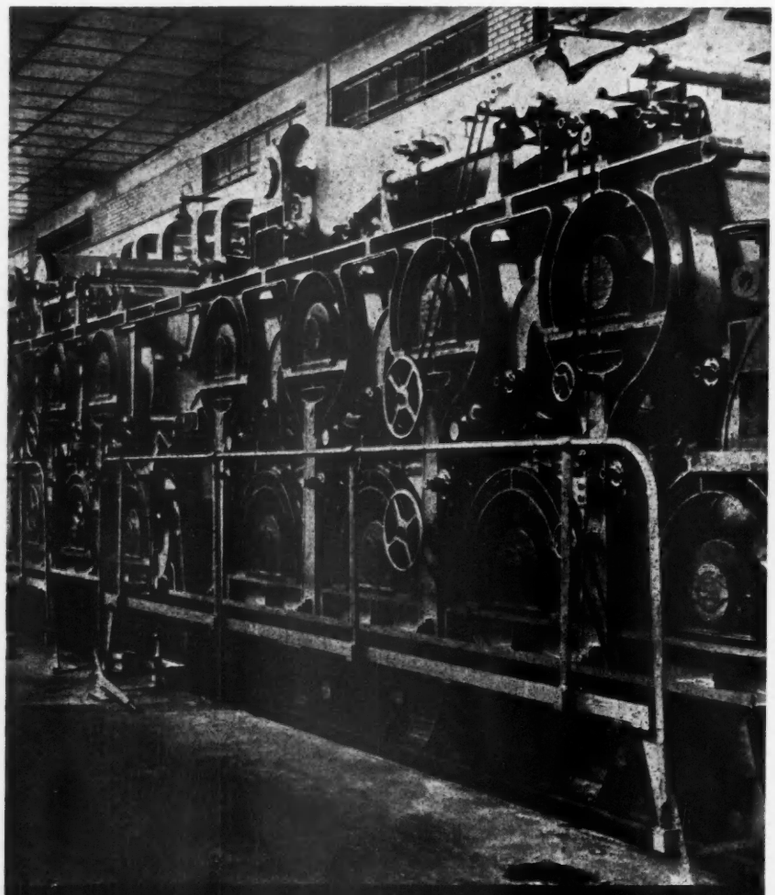

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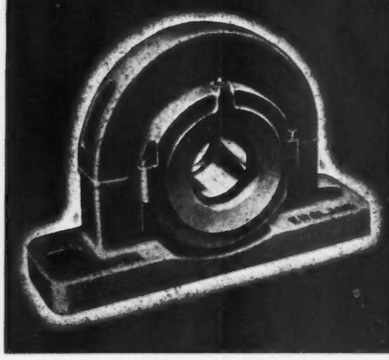

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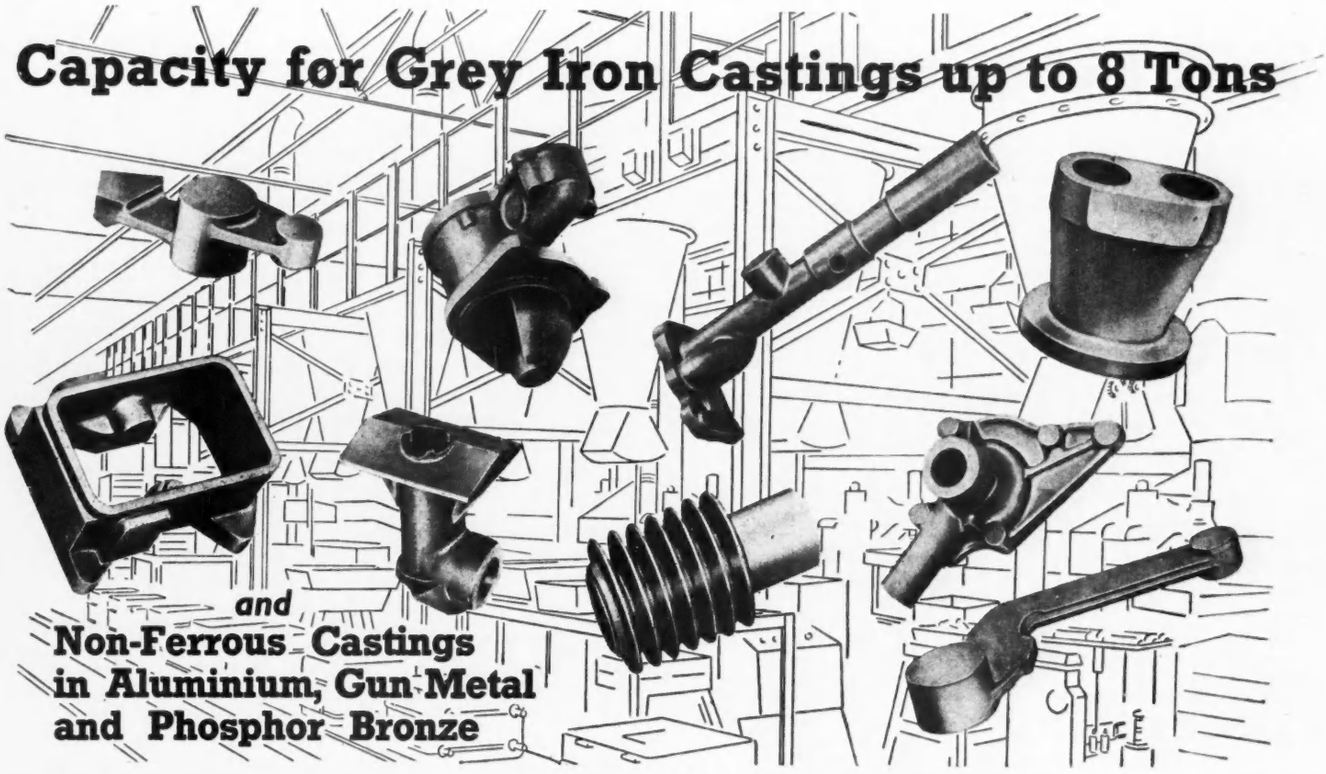

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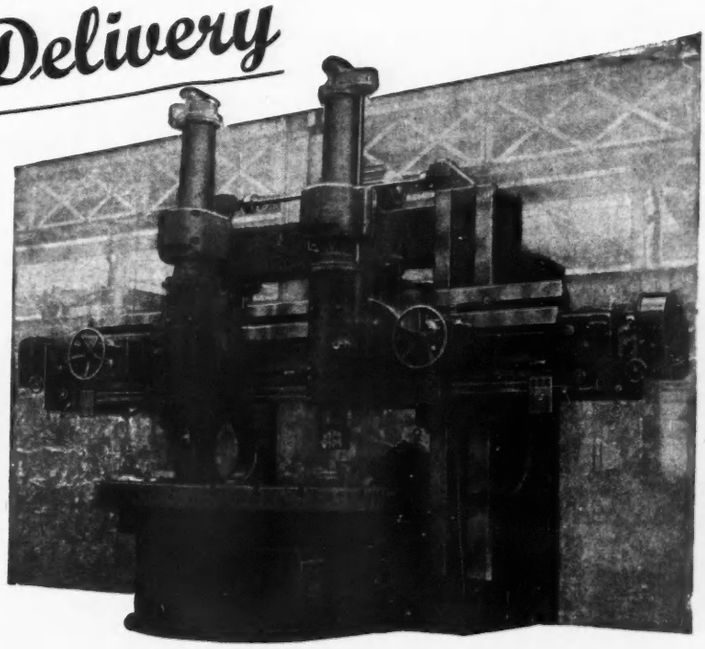

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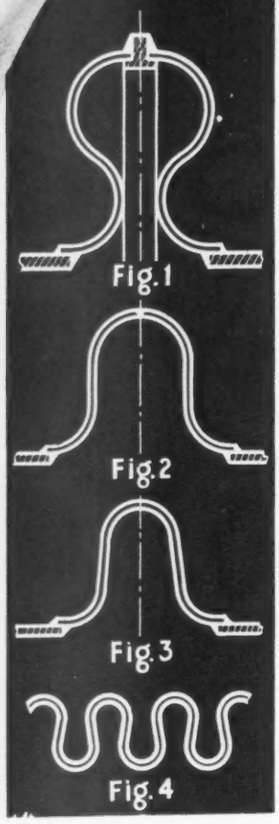

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Fig. 3 A bellows profile which may be formed by deep pressing. This type of expansion fitting is built up in three or more sections with longitudinal welds.

Fig. 4 One of the profiles available for the Aiton "A" type expansion fitting. This unit is made by a special process which obviates the need for circumferential welding at the crown of, and between, convolutions.

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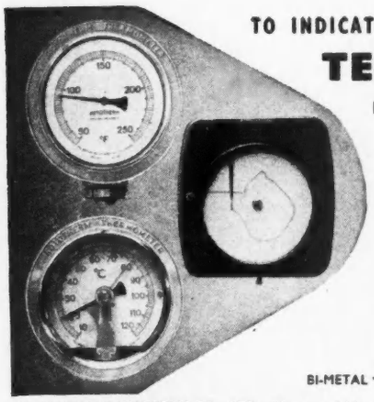

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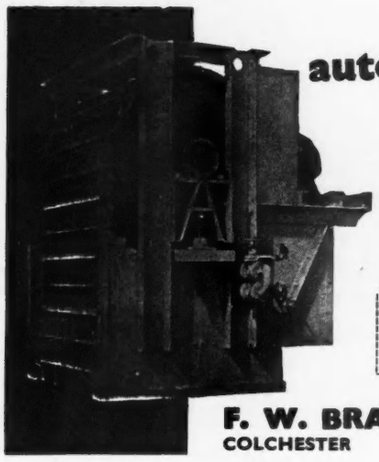

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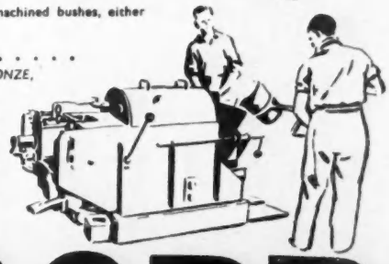

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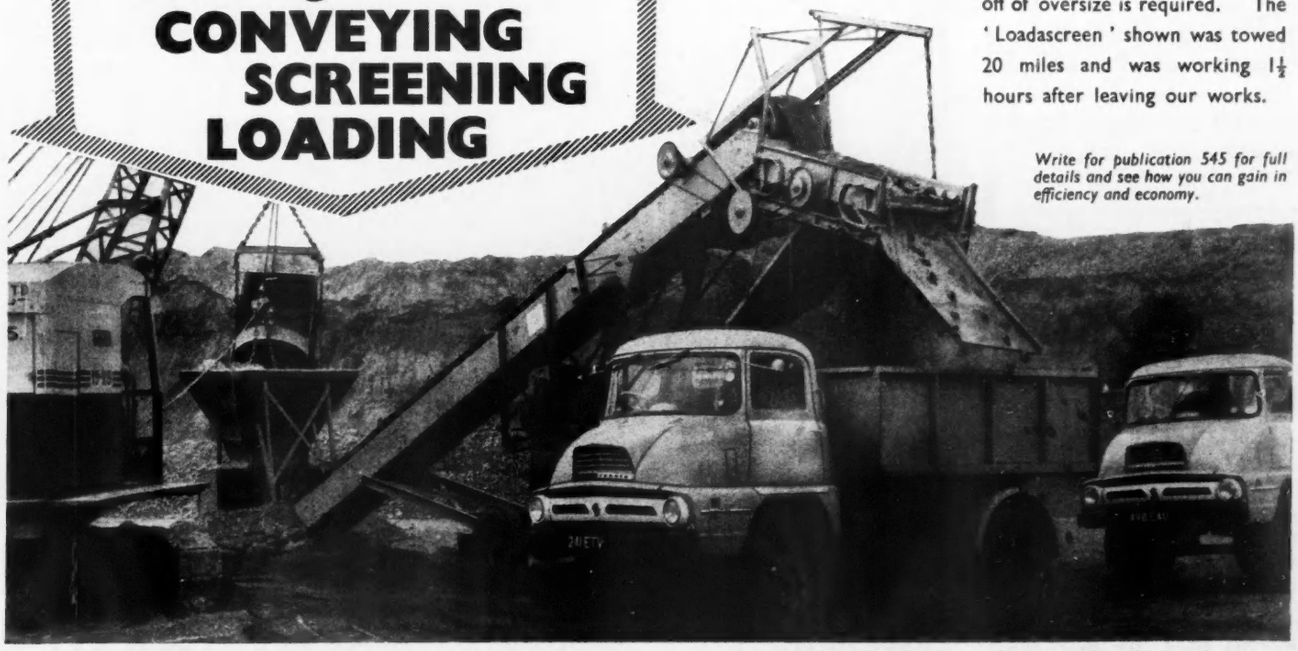

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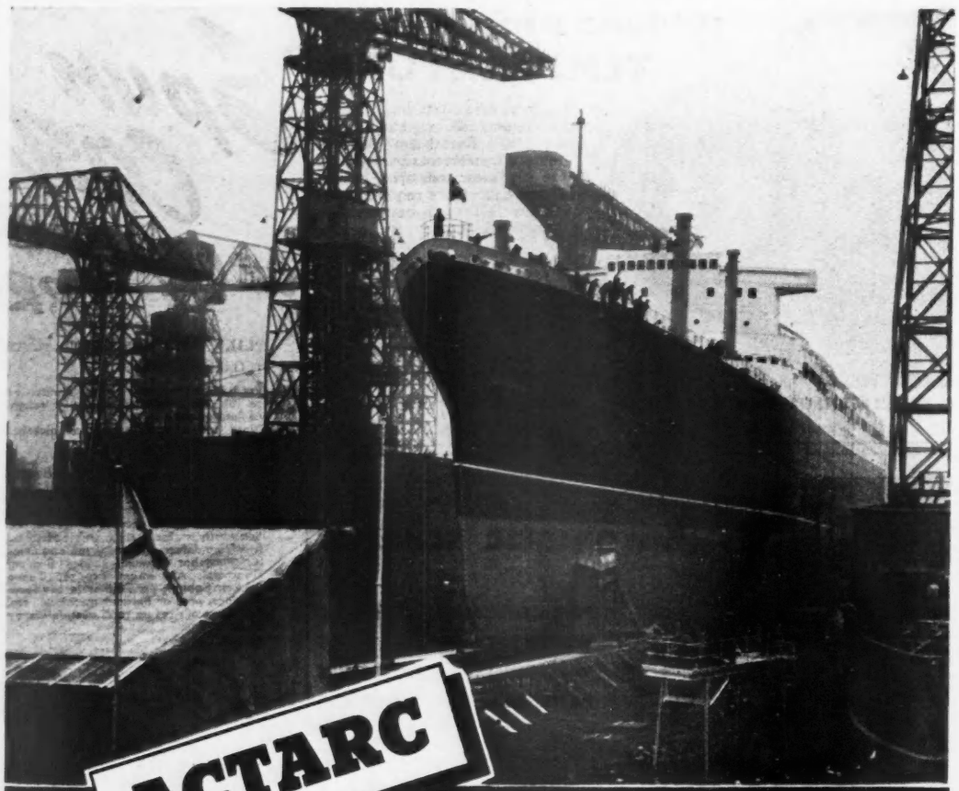

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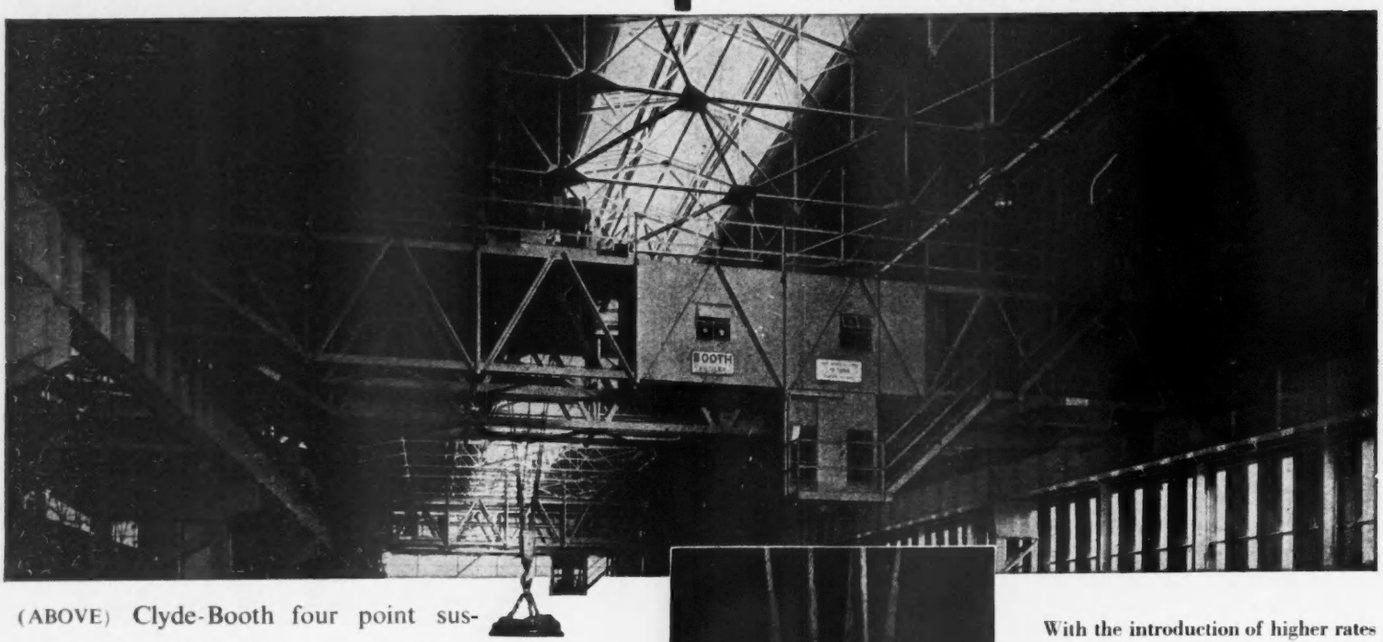
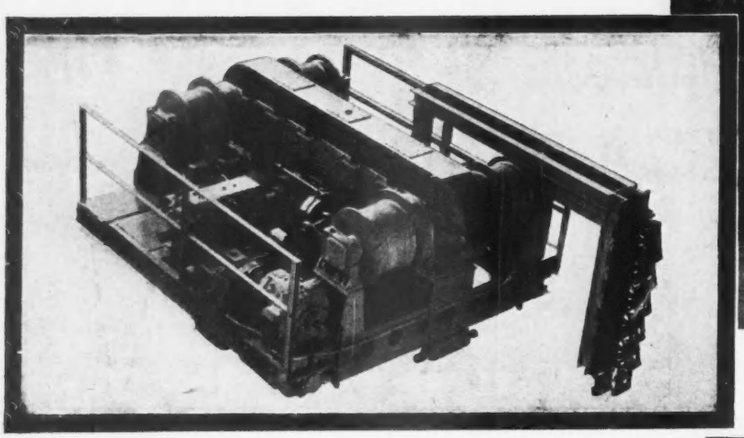


(ABOVE) Clyde-Booth four point suspension electric overhead travelling magnet crane at Messrs. Colvilles Ltd., Ravenscraig Works.
(RIGHT) The hook with slip-ring gear for the magnet, showing attachment of the four ropes.
(BELOW) The special four barrel crab.



With the introduction of higher rates of acceleraton and braking on traversing and long travel motions, in order to get the maximum output from overhead travelling cranes, magnet cranes with multiple splayed ropes are finding favour.

This type of suspension effectively damps out swinging of the load due to acceleration and braking forces.

Clyde-Booth cranes of three and four rope suspension design are produced to meet these requirements.

Our publication "The Booth Handbook on Overhead Cranes" is available on request.

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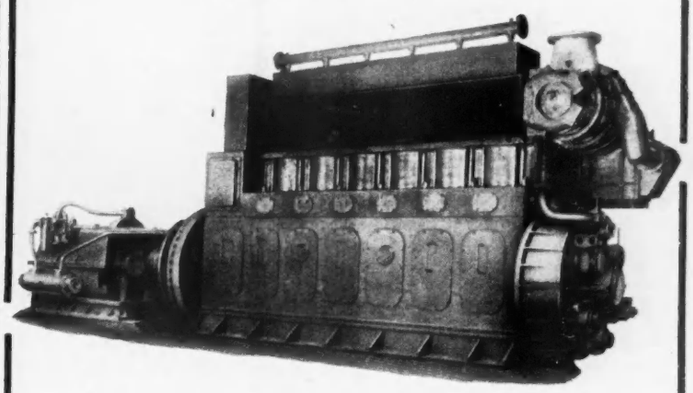

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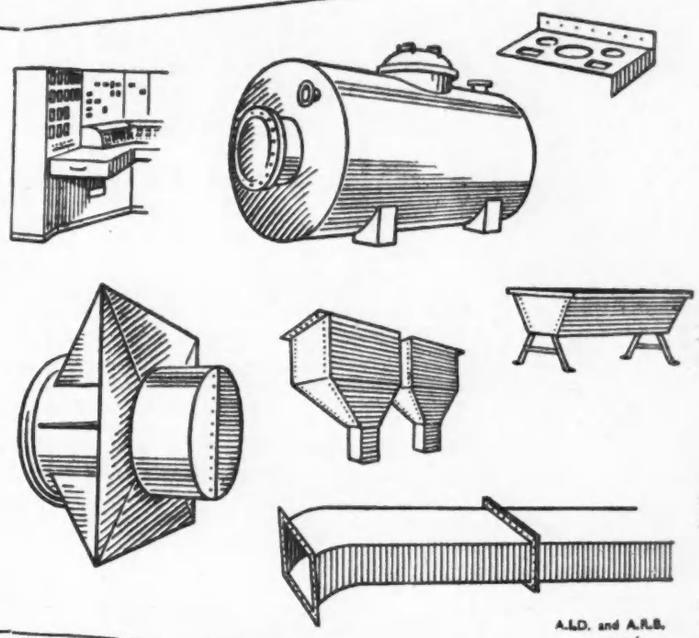

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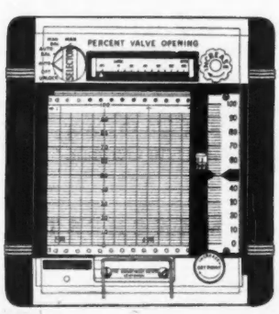

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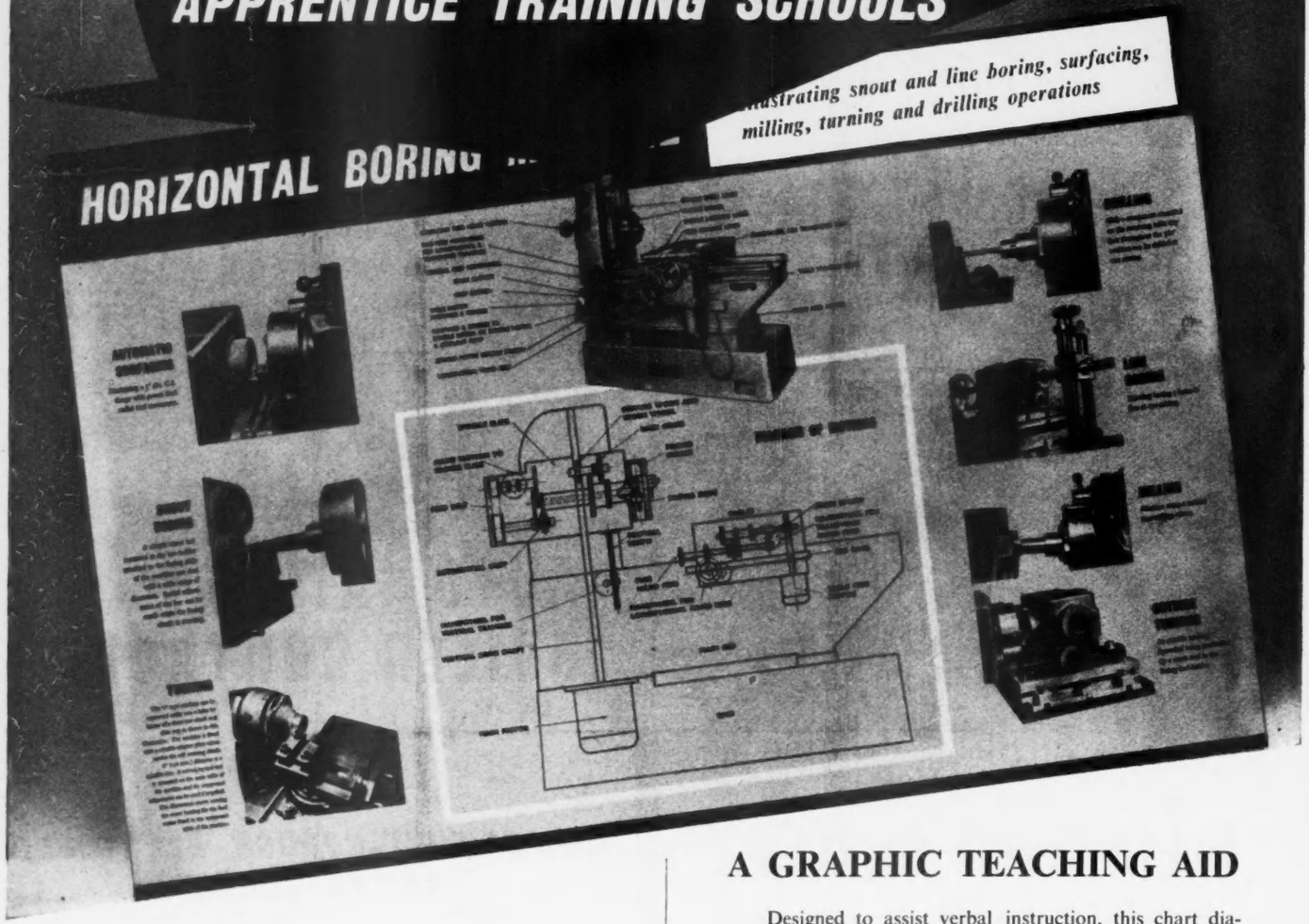

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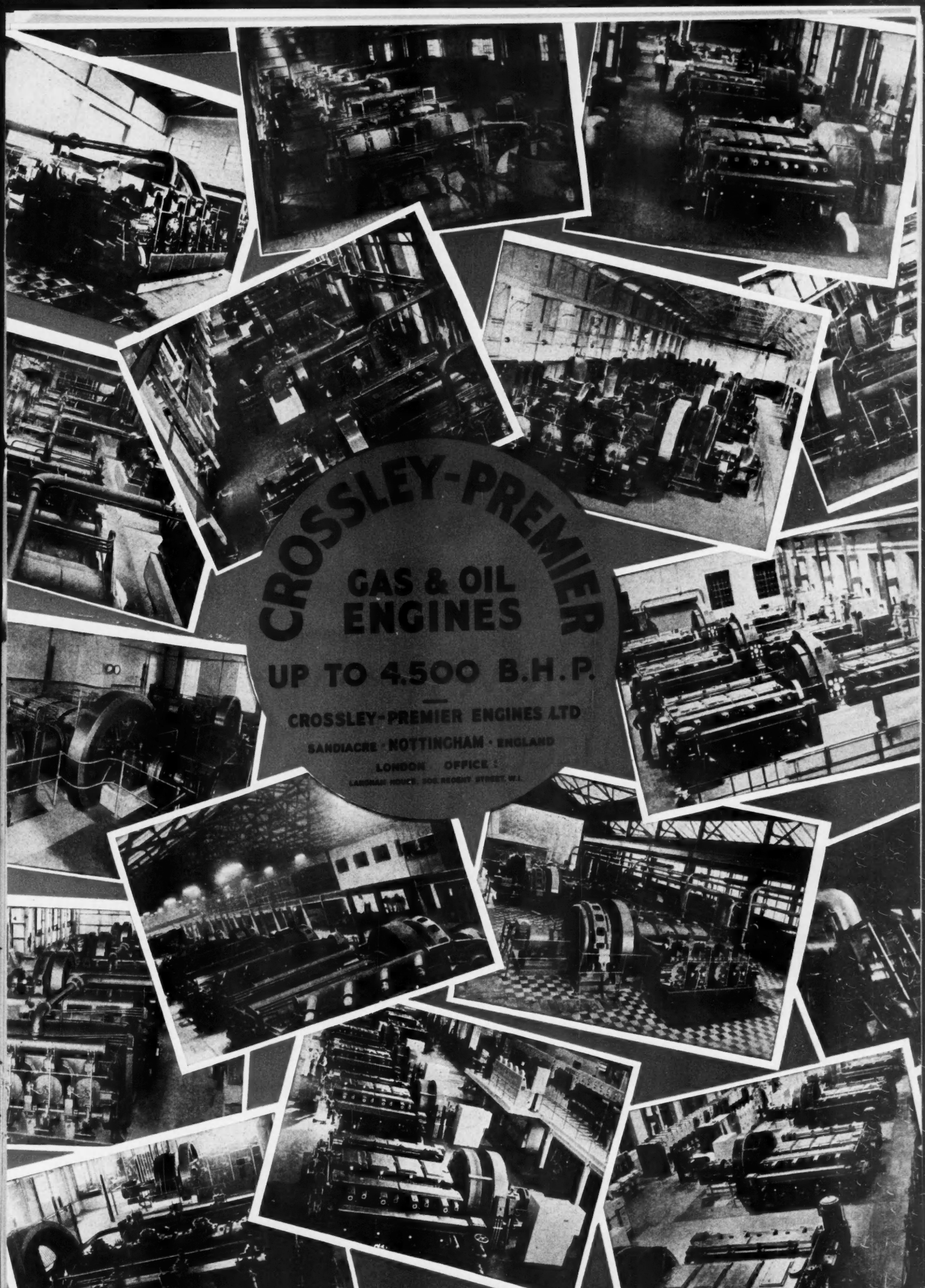
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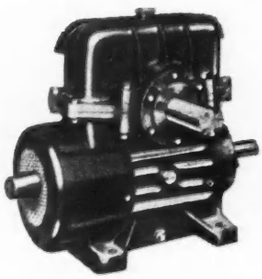

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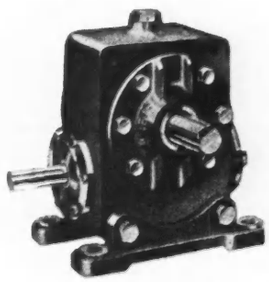

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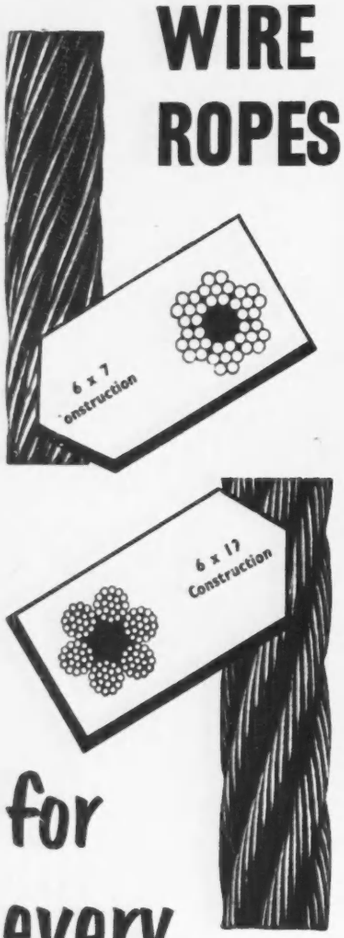

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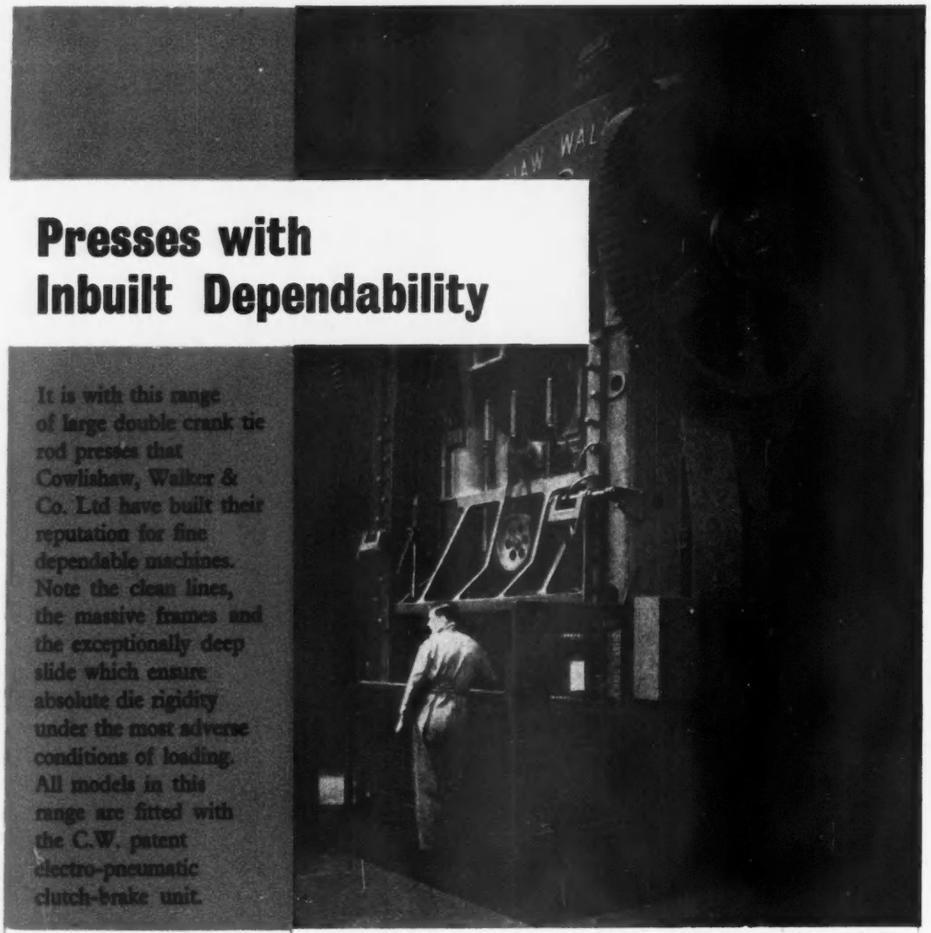

It is with this range of large double crank tie rod presses that Cowlishaw, Walker & Co. Ltd have built their reputation for fine dependable machines. Note the clean lines, the massive frames and the exceptionally deep slide which ensure absolute die rigidity under the most adverse conditions of loading. All models in this range are fitted with the C.W. patent electro-pneumatic clutch-brake unit.

A selection from the range of C.W. double-crank presses

PRESS TYPE	OC.10	MF.14	UF.16	LN.24	YV.34
RATING: TONS	150	300	400	650	1500
CRANK DIA. ins.	7½	8½	10	12	15
BETWEEN SIDES ins.	75½	63	109½	109½	130½
STROKE ins.	10	14	16	24	34
SLIDE F to B x R to L ins.	30 x 68½	42 x 54	54 x 99½	63 x 99	70 x 120
BED F to B x R to L ins.	36 x 72	60 x 61	60 x 108	76 x 108	70 x 129
CUSHION: TONS	28	50	81	101	150

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Electrical Aids in Industry *Data Sheet* **No. 6**

Lighting-1

Good lighting affects productivity in three ways: (1) by directly increasing the speed of working and reducing errors and wastage; (2) by improving overall factory efficiency through better supervision and housekeeping; (3) by providing better working conditions, thus improving labour relations and avoiding frequent changes of workpeople.

It is not possible to judge by the eye alone whether the lighting in any factory is good enough to serve these purposes because the eye has a tremendous range of adaptation (vision of some kind is possible within an illumination range of 1,000,000 to 1) and is hence an unreliable measuring instrument. Severe mental and eye strain or unconscious slackening of working speed may occur under lighting which *appears* to be adequate.

The only reliable way to appraise factory lighting is to conduct a lighting survey using a lightmeter, an inexpensive instrument which measures the actual illumination available. These figures can then be compared with official recommended values for the various tasks.

Lighting Survey

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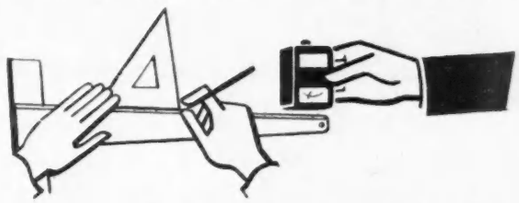
NATURE OF WORK, PROCESS OR MATERIAL	ILLUMINATION LUMENS/SQ. FT.
Rough or routine work. Large detail. Medium to light material of good contrast.	7
As above, but work rather more skilled or critical.	10
Ordinary work usually involving workers' inspection. Medium detail and contrast.	15
Fairly critical work, fairly small detail or poor contrast.	20
Skilled work, small detail or dark material.	30
Fine or critical work, very small detail, very poor contrast or very dark material.	50
Very fine exacting work.	100
Minute work.	200

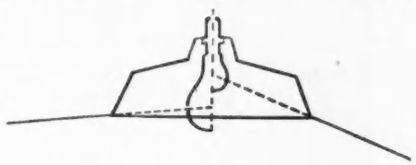
In addition, readings should be taken at selected working points with the lightmeter so placed that it measures the light on the work while the operative



is working. This will indicate whether full use is being made of the light or whether shadow is obscuring part of it.

Glare

Any direct light on the eye tends to reduce its sensitivity —thus reducing the power to see. Increasing the intensity of the light source may therefore not improve



matters unless care is taken to avoid glare either by correct positioning or by the use of correctly matched reflectors and lamps.

Walls and Ceilings

Certain surfaces and certain colours absorb light and therefore do not make the best of a light source; others reflect light and, so to speak, feed back on to the work a portion of the lighting which would otherwise be lost. Bright walls, moreover, have a good psychological effect which makes for contented—and therefore productive—operatives.

Shadows

Unnecessary shadows may seriously slow down work and also cause accidents. Lightmeter readings should always be taken under conditions exactly similar to those obtaining while work is going on. The operative himself may mask his work, an overhead crane or a heavily loaded conveyor belt may periodically obscure a light fitting, or a dust-laden atmosphere may reduce the designed lighting values.

For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

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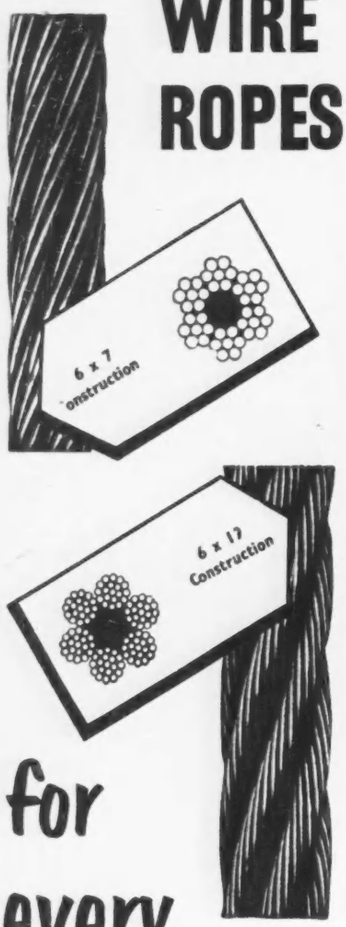

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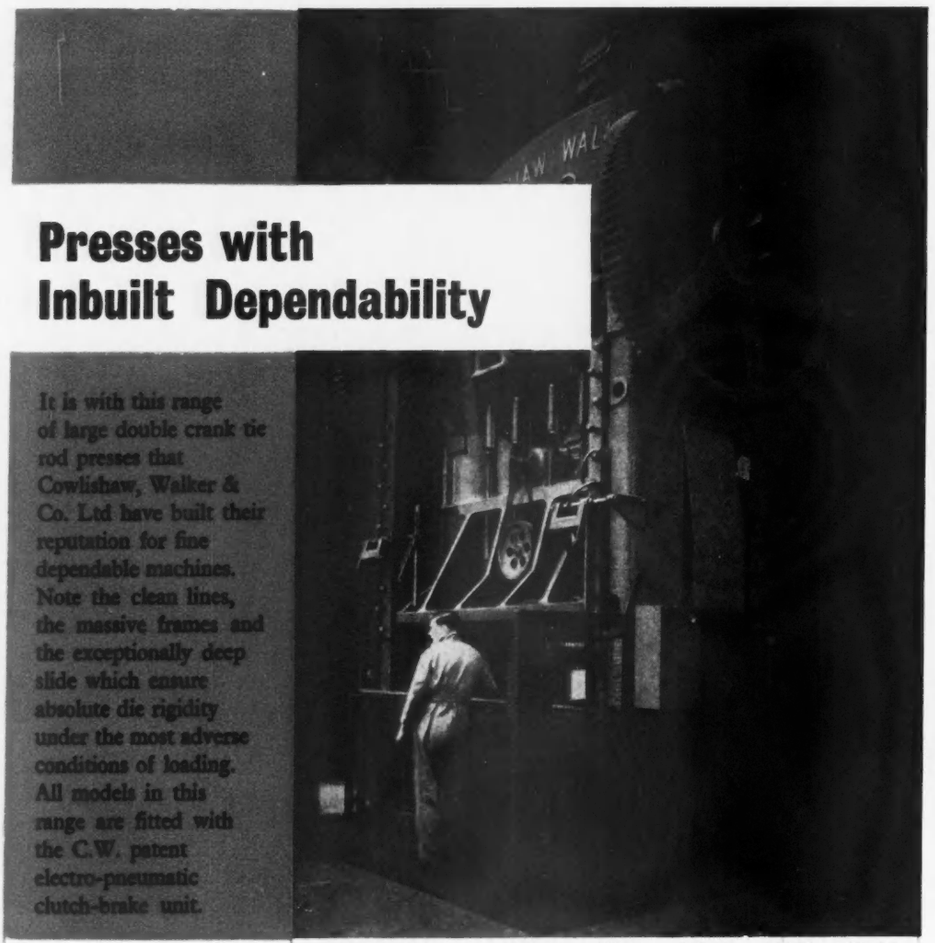

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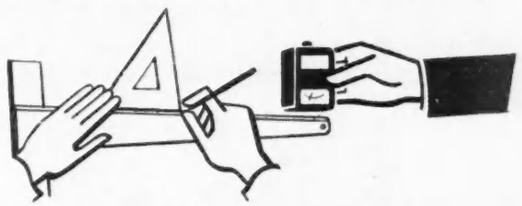

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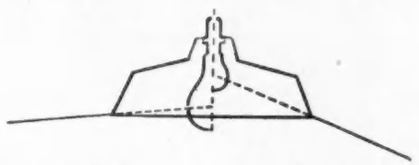

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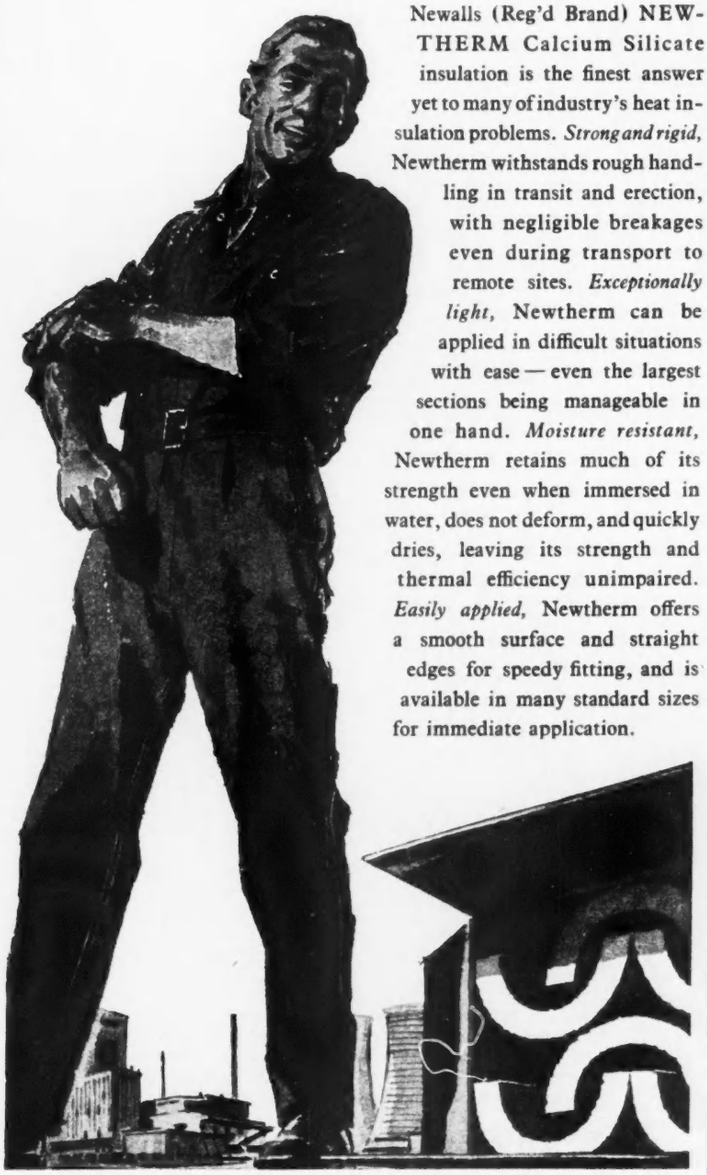

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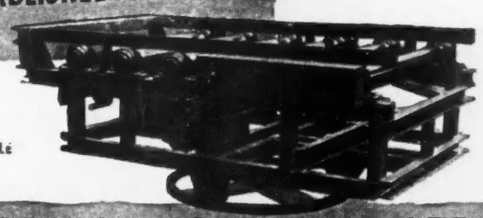

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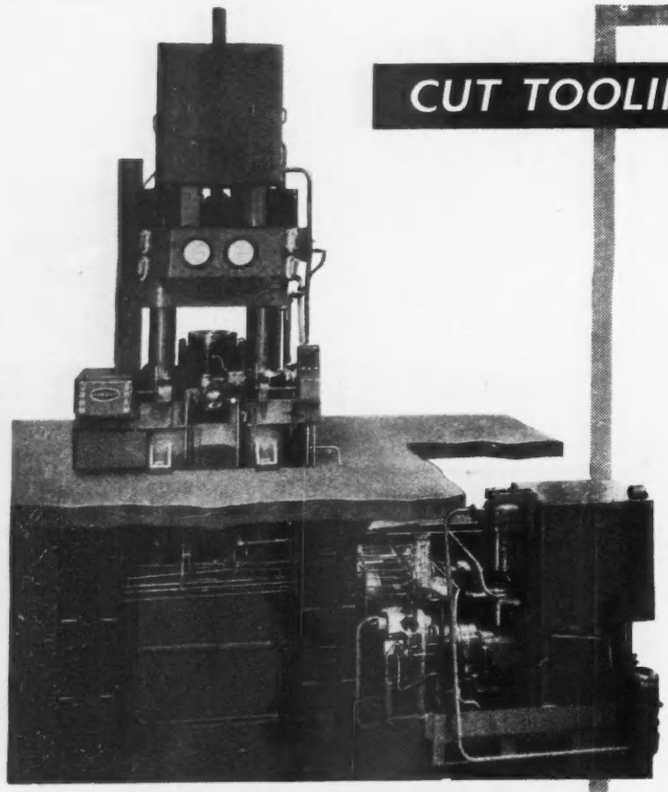

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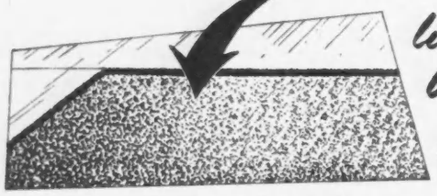

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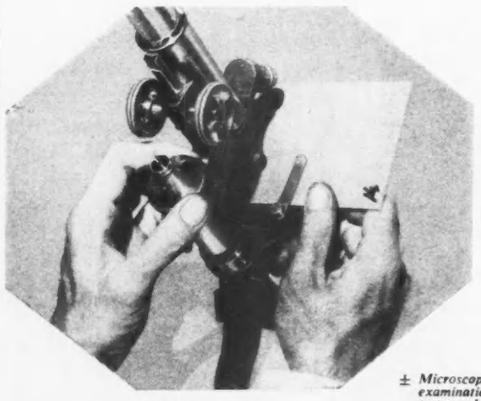

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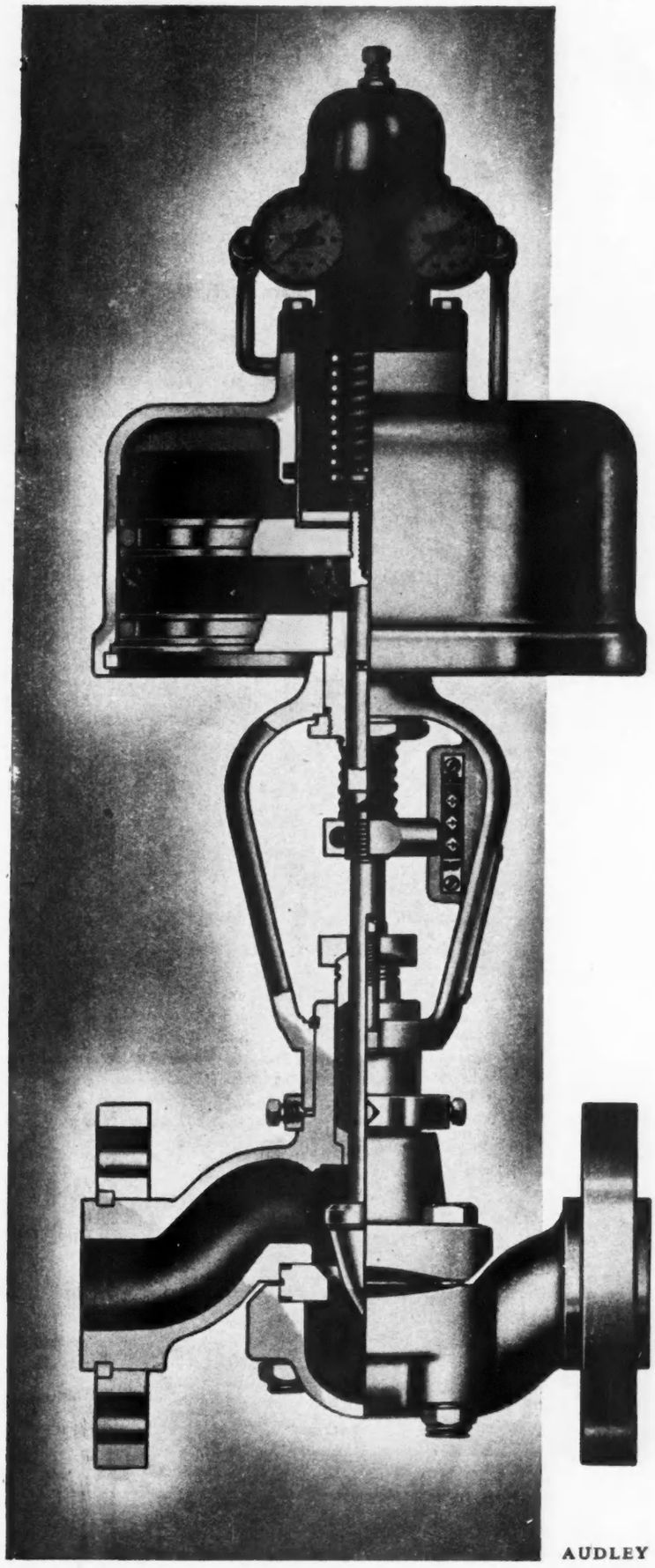

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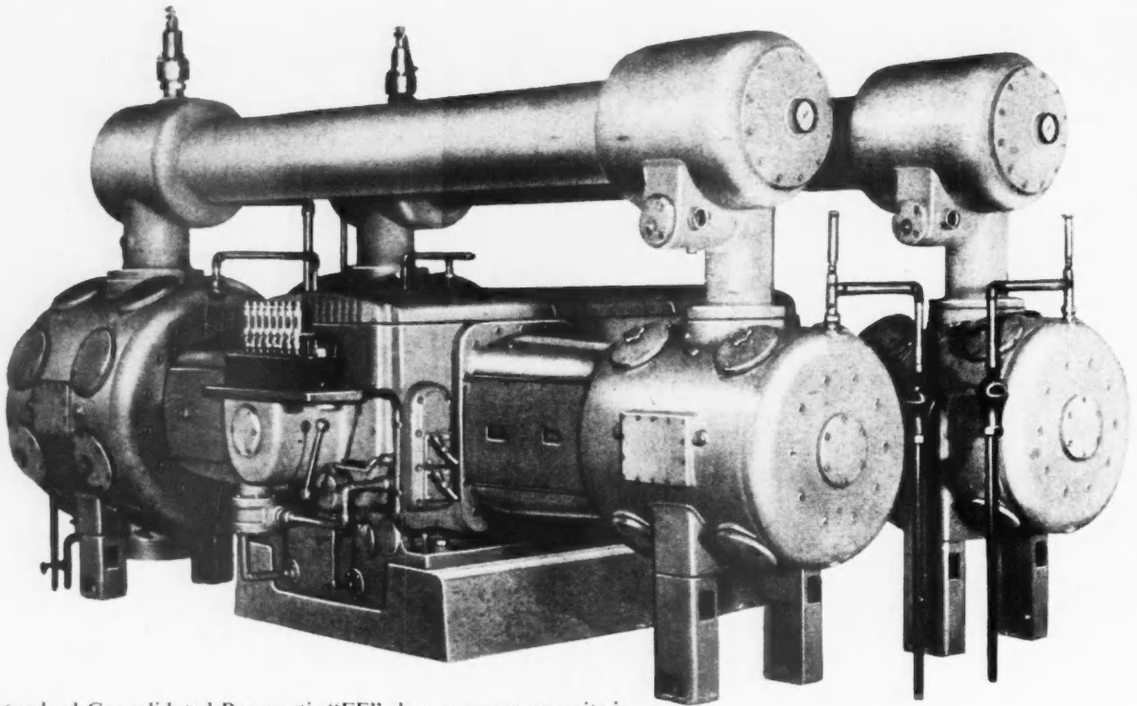
Class "FE" compressors are suitable for handling gasses other than air.



A Consolidated Pneumatic four-cylinder, four-crank, two-stage, double-acting horizontal balanced-opposed Class FE-42 Compressor. This unit requires 650 H.P. and delivers 3600 c.f.m. at 100 p.s.i. working pressure.

The advantage of standard Consolidated Pneumatic "FE" class compressor units is that they can be built up into single or multi-stage installations giving outputs up to 5000 c.f.m. or pressures up to 3000 p.s.i. to suit *exact individual* requirements, thus giving the most efficient return in terms of air delivered for power consumed. And, because the machines consist of standard units, the basic engineering cost of the plant as a whole is lower. Further, the virtues of the balanced-opposed design of these units are such as to effect considerable savings in foundation work, floor space and maintenance costs. In every way, "FE" compressors mean air at lower cost.

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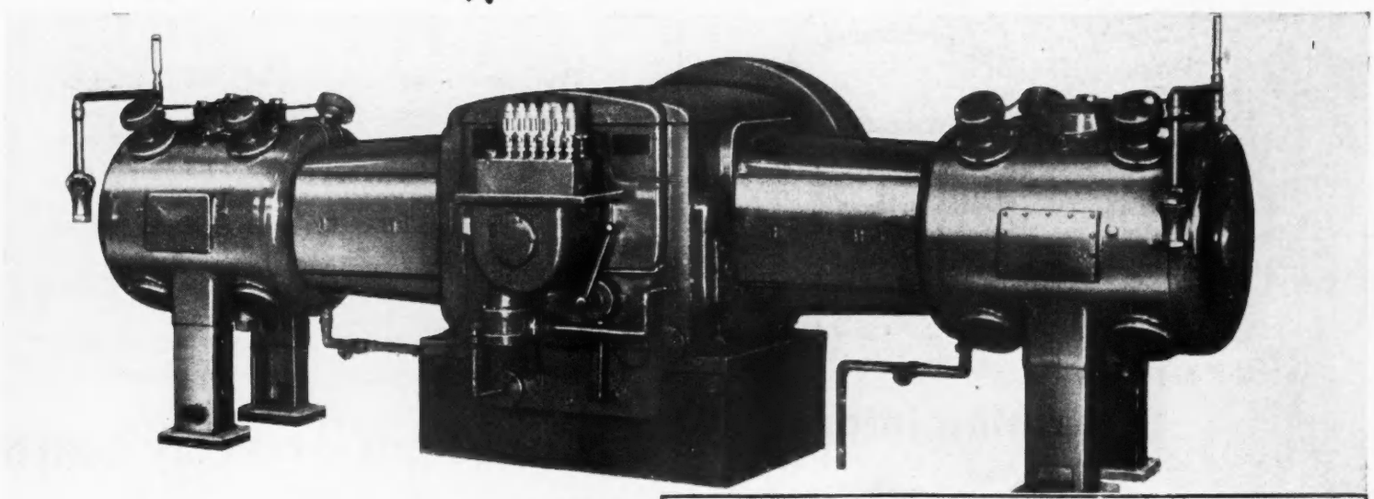
big-user class*

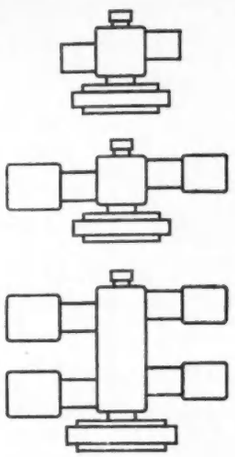
*** up to 5000 c.f.m. or 3000 p.s.i.**



A Consolidated Pneumatic two-cylinder, two-crank single-stage, double-acting, horizontal balanced-opposed Class FE-21 Compressor. This unit requires 250 H.P. and is designed for boosting natural gasses to a pressure of 75 p.s.i.

ADVANTAGES OF THE BALANCED-OPPOSED DESIGN

In the "FE" compressors, the crankcase and frame are centrally positioned with cylinders on opposing sides, the drive being obtained by a double-throw crankshaft. The resulting perfect dynamic balance makes for far greater compactness and virtual freedom from vibration, space and foundation work being reduced to a minimum. Also, the considerably smaller load imposed on main bearings, together with slow operating speed, ensure an extremely long life of continuous operation with very little maintenance.



1. The basic Class "FE" crankcase and running gear, showing also compactness achieved by using engine-type, salient-pole motor.
2. Different-size cylinders can be fitted, one-, two-, three- or four-stage machines being available.
3. Large outputs are obtained by increasing the number of cylinders and working off a common crankshaft.

For further information complete this form and pin it to your letter heading.

This form will bring you a descriptive catalogue on Class "FE" Compressors, but if you would like advice on a projected plant, your enquiry can be dealt with more expeditiously if the following information can be provided:

1. Output required in cubic feet per minute at intake pressure and temperature. .....
2. Intake temperature and humidity. .....
3. Intake pressure. .....
4. Discharge pressure. .....
5. Type of drive motor, voltage, etc. .....
6. Temperature of cooling water and type of cooling circuit. .....
7. Aftercooler, if required, and temperature of air at discharge from aftercooler. .....
8. Purpose for which compressor is to be used. .....

23

CP165

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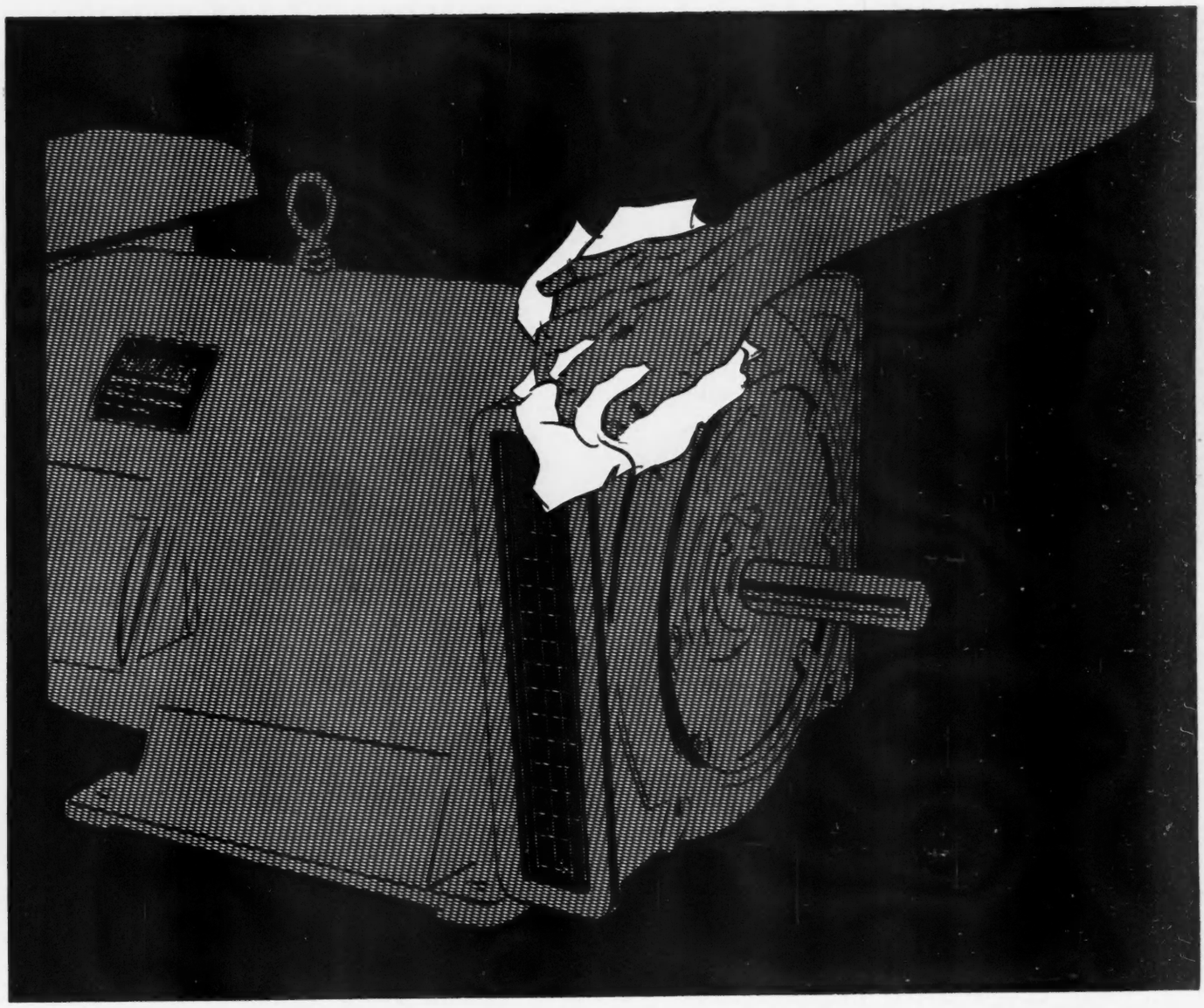

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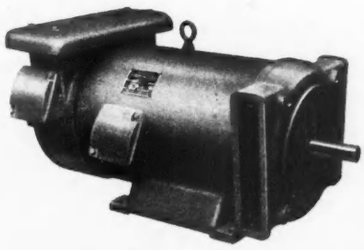

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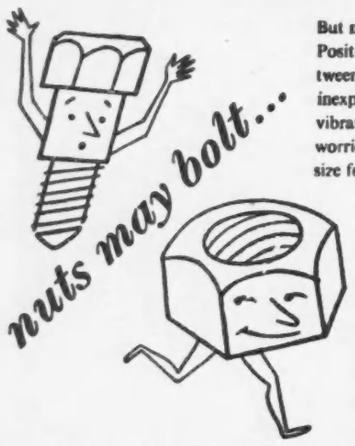

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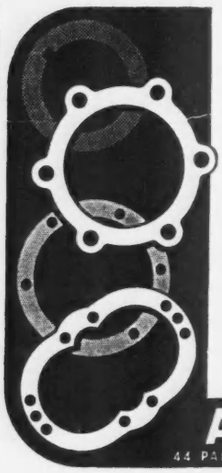

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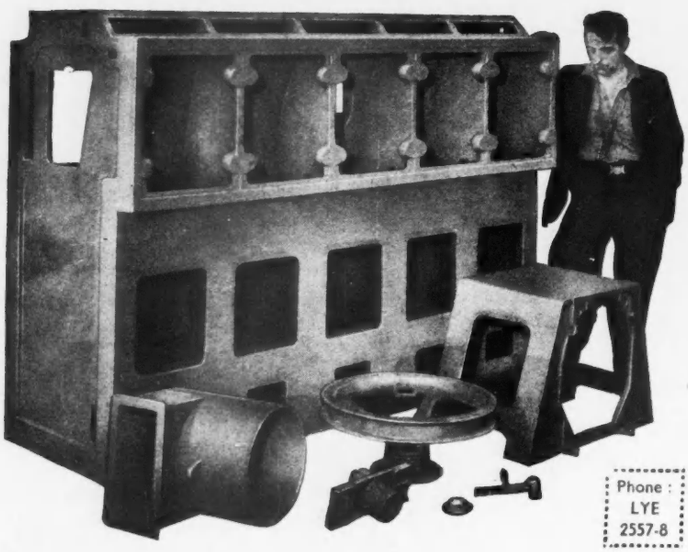

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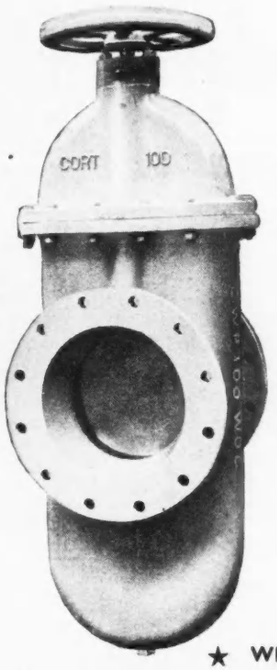

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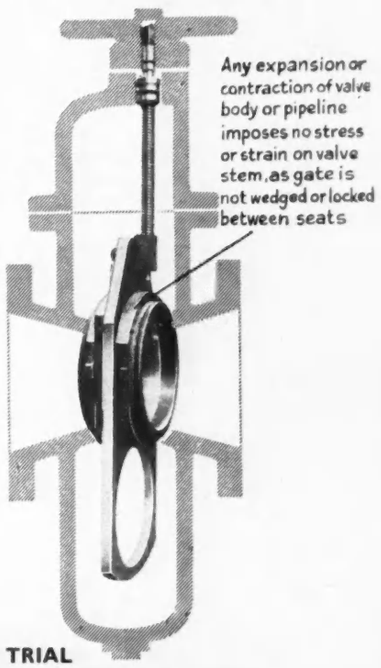
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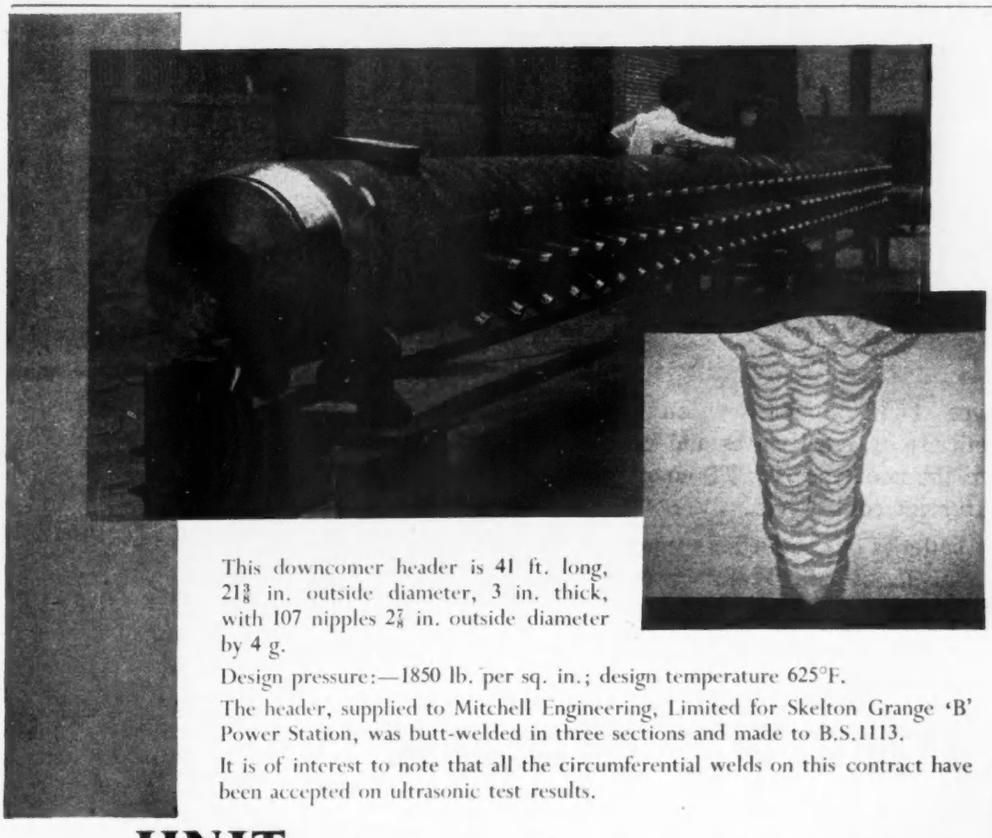

A Top Downcomer Header

In the large illustration the centre butt-weld is being subjected to an ultrasonic test; the inset shows a macro section of a similar weld which has been deposited in fifty-eight runs.

This downcomer header is 41 ft. long, 21⅜ in. outside diameter, 3 in. thick, with 107 nipples 2⅞ in. outside diameter by 4 g.

Design pressure:—1850 lb. per sq. in.; design temperature 625°F.

The header, supplied to Mitchell Engineering, Limited for Skelton Grange 'B' Power Station, was butt-welded in three sections and made to B.S.1113.

It is of interest to note that all the circumferential welds on this contract have been accepted on ultrasonic test results.

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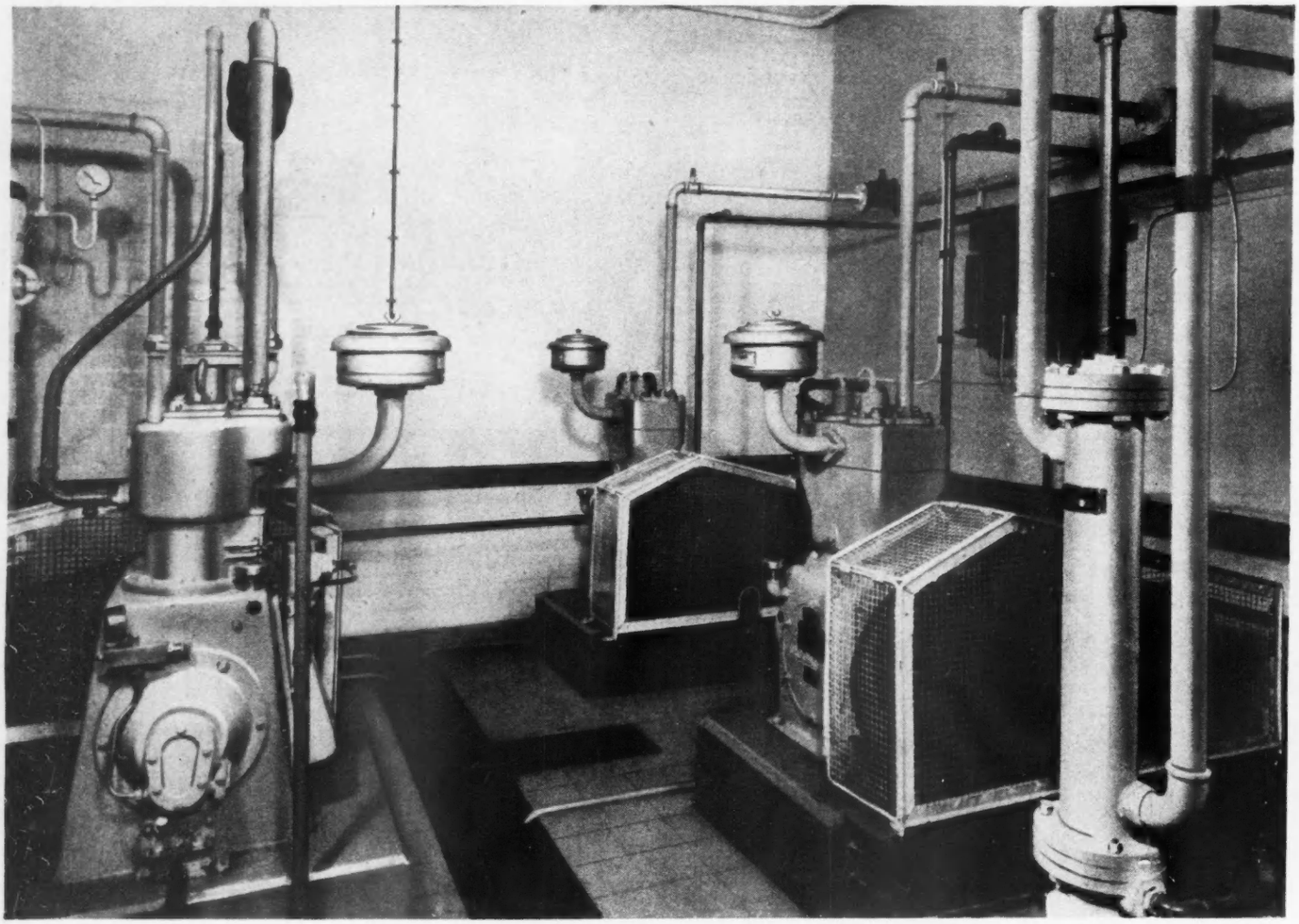

Photograph by courtesy of Colthrop Board & Paper Mills, Ltd.

The type D.21 compressor on the left supplies air for pneumatically operated valves and general workshop duties, whilst air from the two type EH 220 compressors on the right is used for instrument control, etc.

Further batteries of compressors supply air for pneumatic loadings on one of the Board Machines and to Winder Clutches and Presser Rolls on the Stack Dryers.

For efficiency, economy and reliability, "BROOMWADE" pneumatic equipment is unsurpassed.

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"Purrrr!"

"Since they fitted L & C Piston Rings, I mean"

"Purrrr!"

"Engines runnin' as sweet and smooth as a bowl o' cream, ain't they?"

"Purrrr!"

"How would you sum up these L & C rings, Puss?"

"Purr-fect!"

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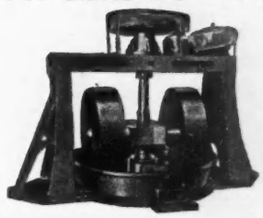

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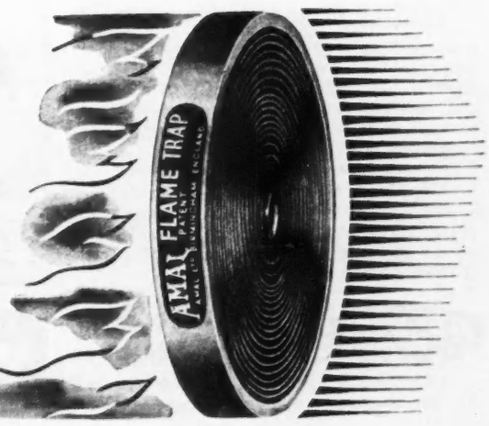

Enquiries to:—
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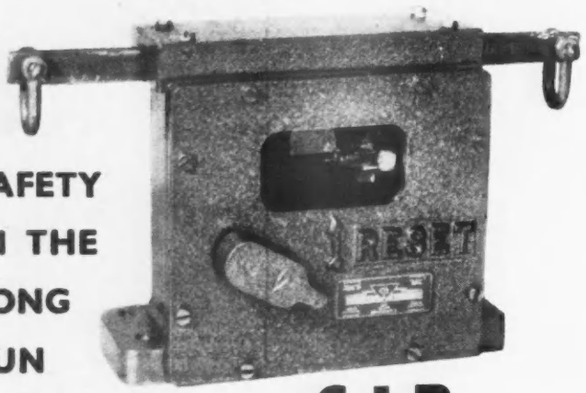

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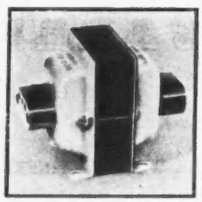
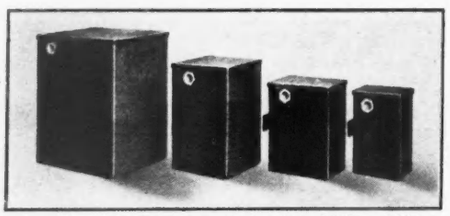
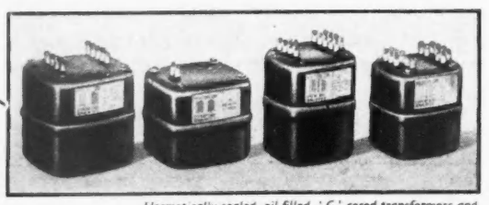




Encased transformer for indoor use made to B.S.171 or B.S.794 in ratings up to 5 KVA single phase and 20 KVA three phase at 50 cps.

Fully shrouded single phase transformer for ratings up to 500 VA at 50 cps.



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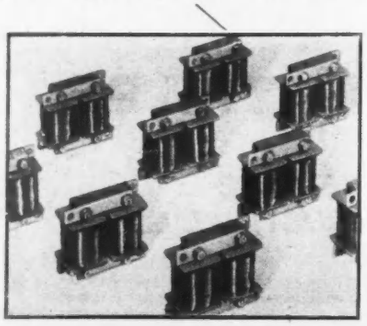
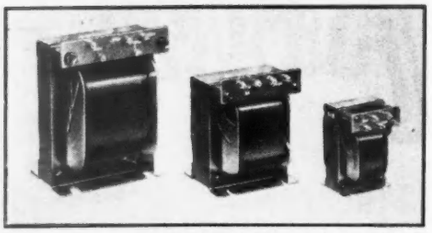


One of a range of special transformers and chokes made to customer's specification.



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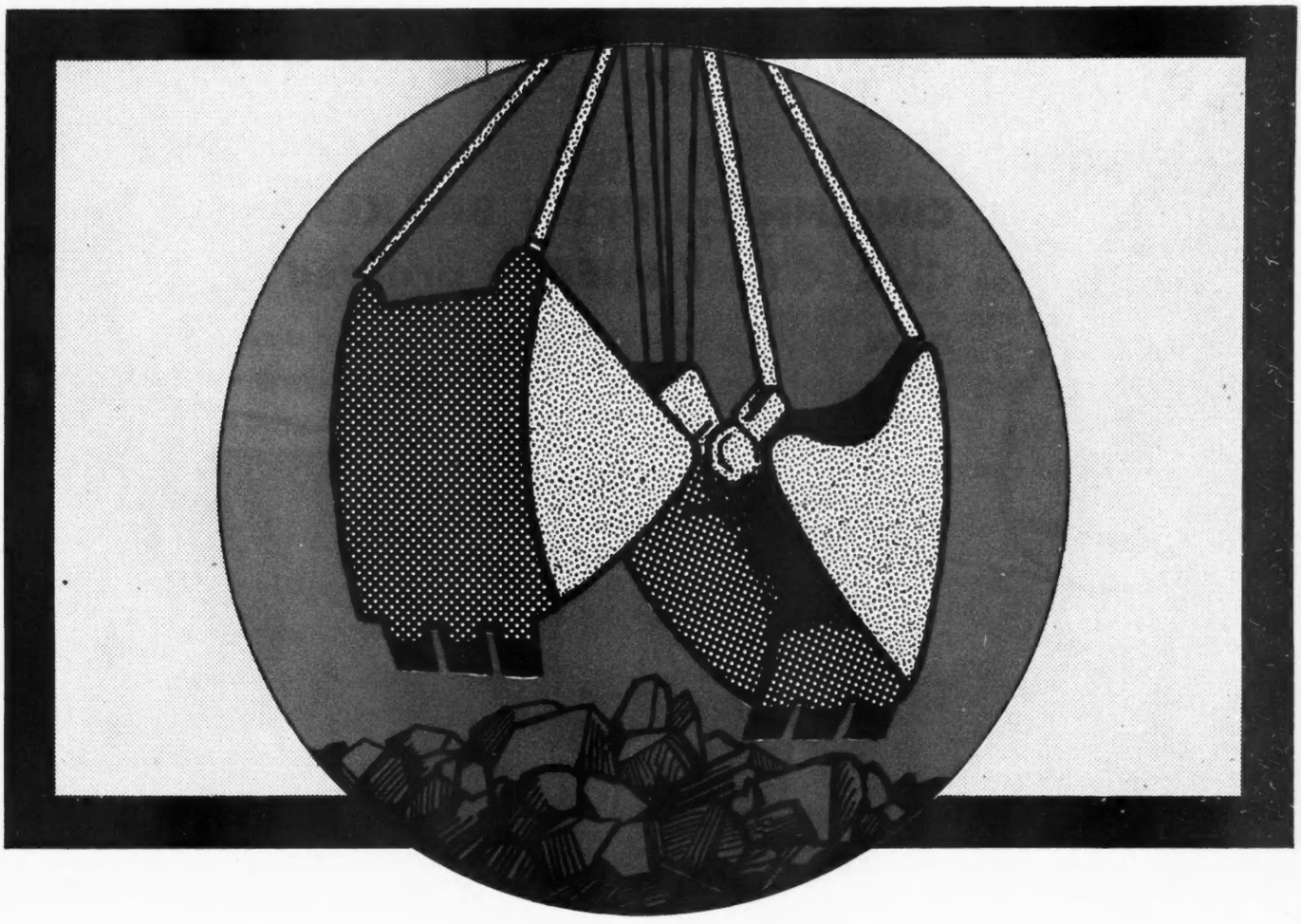

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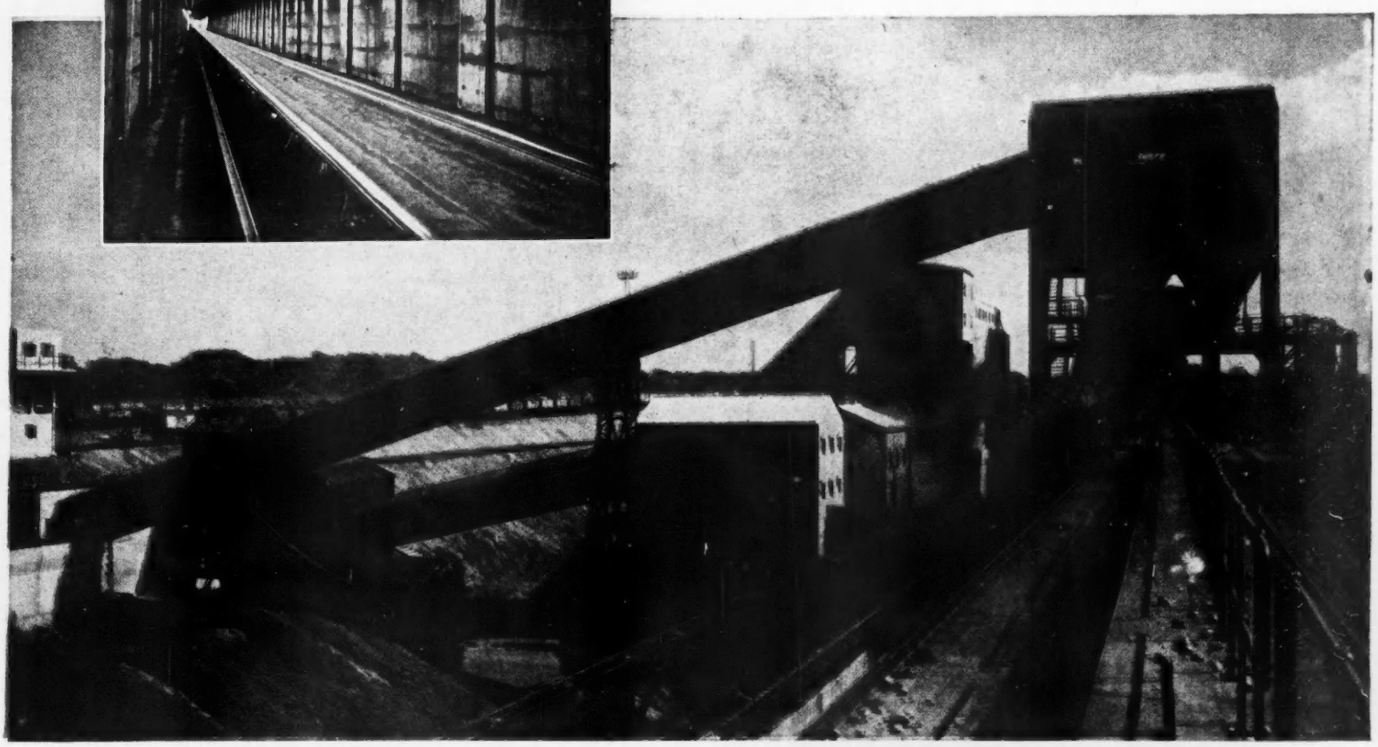
A 60" wide Conveyor installation at Messrs. John Summers Ltd.

Iron-ore conveyor system at Messrs. Colvilles new plant at Ravenscraig.



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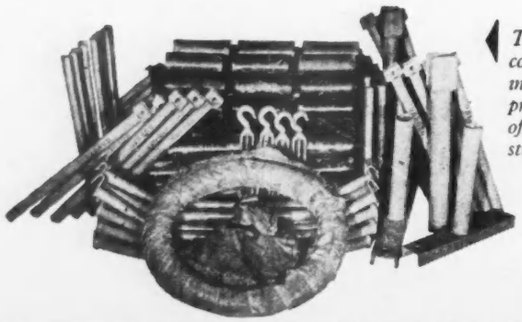
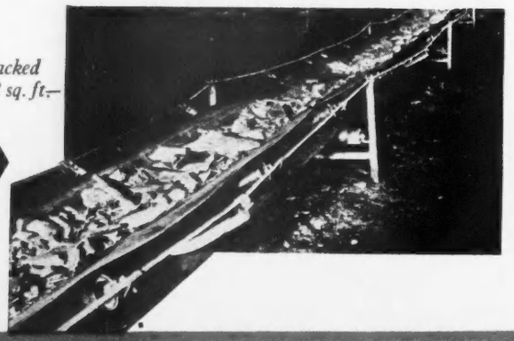
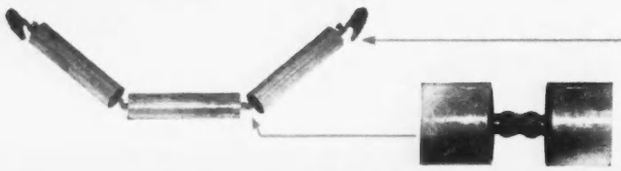


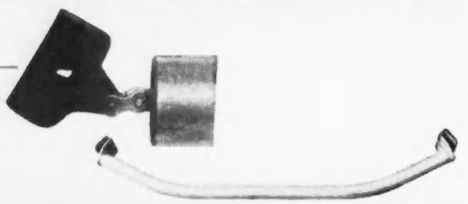
This group of components—stacked in an area of 28 sq. ft.—produce 200 ft. of this conveyor structure . . . .



DISTINGTON-GOODMAN ROPE BELT CONVEYOR STRUCTURE patented



swivel links are fitted at each end of an idler shaft



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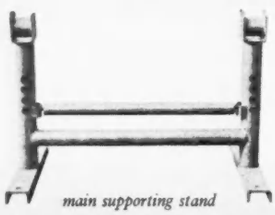
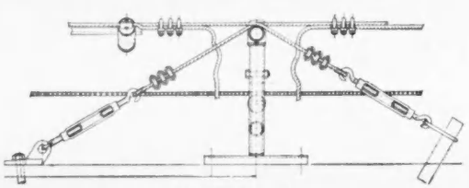
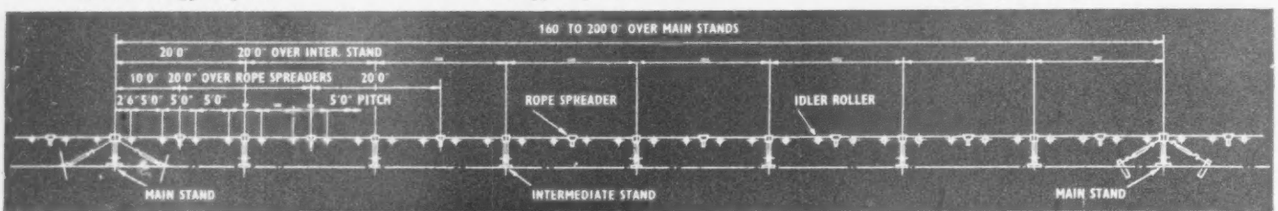
intermediate supporting stand



main supporting stand

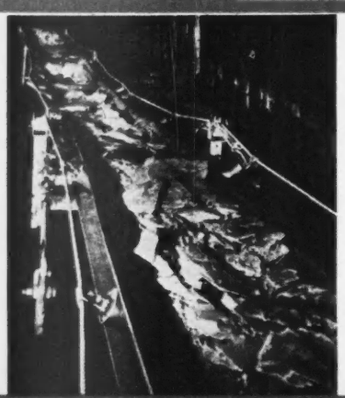


typical rope anchorages



Installation, extension and contraction of Distington-Goodman Rope Belt Conveyor Structure is relatively quick and easy.

(Right) Detail of a main stand and anchor point. These can be spaced up to 400' apart according to requirements.



A 36" rope belt conveyor installed at a quarry, carrying 500 tons of gravel per hour. By securing the rope to terminal pulleys it has proved practicable to move this conveyor bodily sideways by the dragline shown in the illustration.

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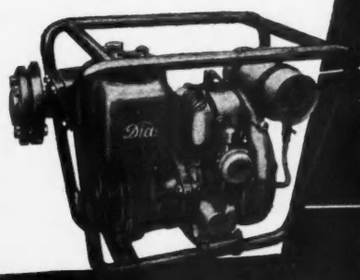

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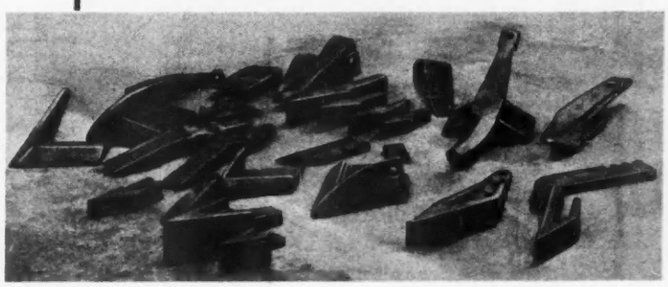

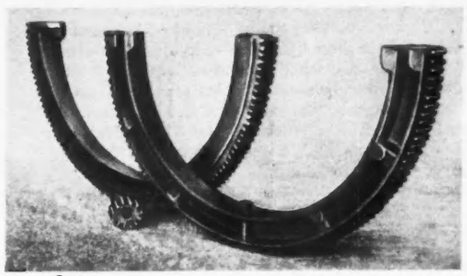

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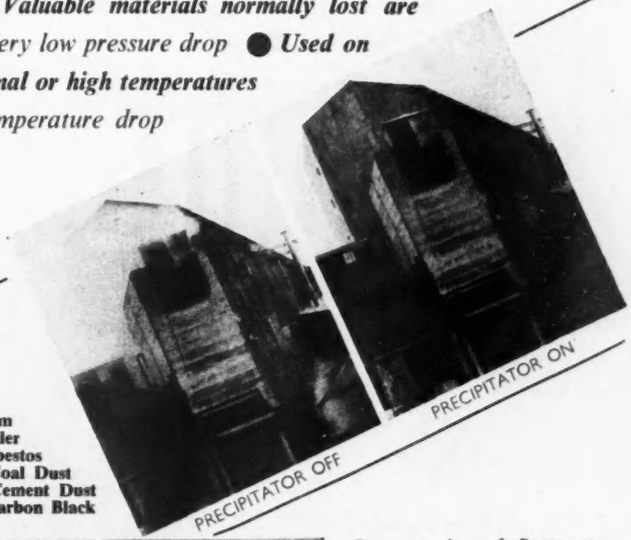

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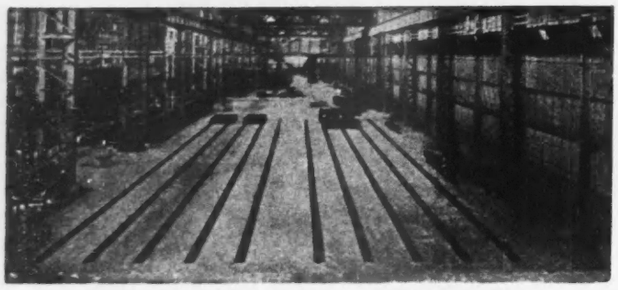

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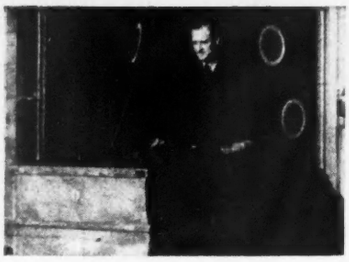

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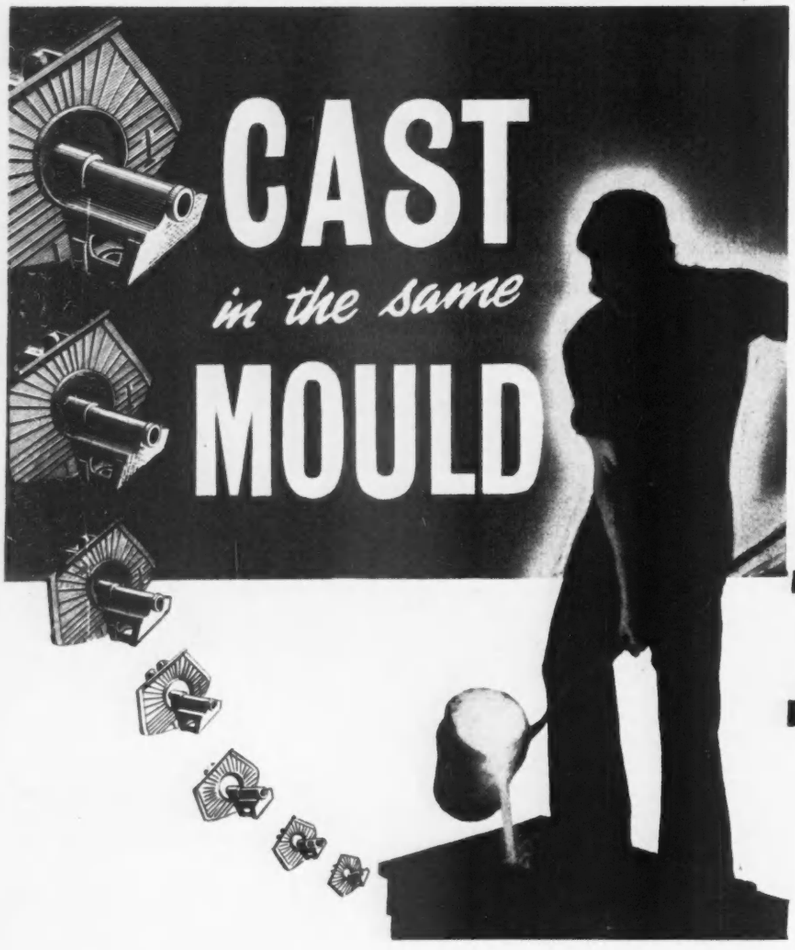

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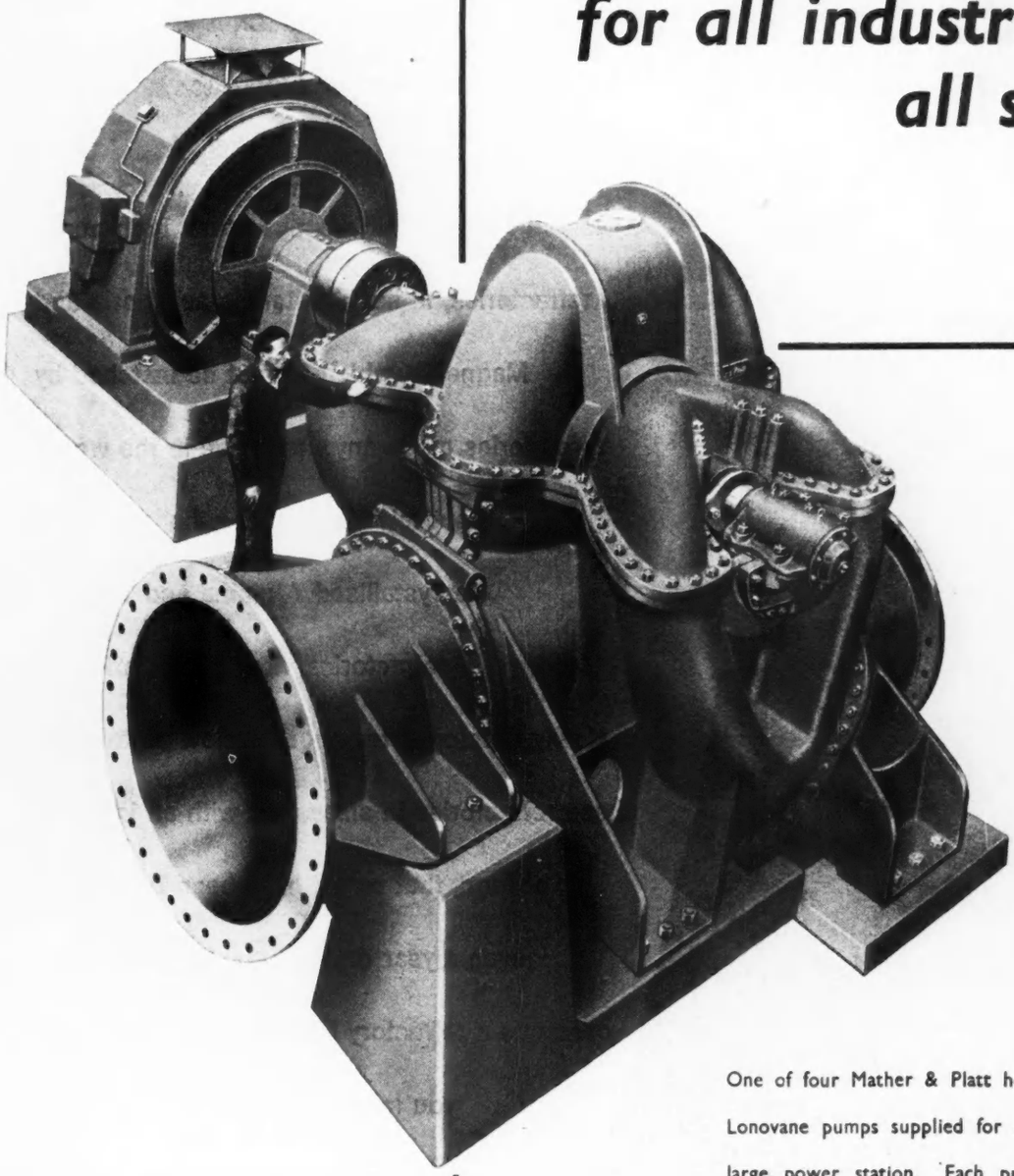

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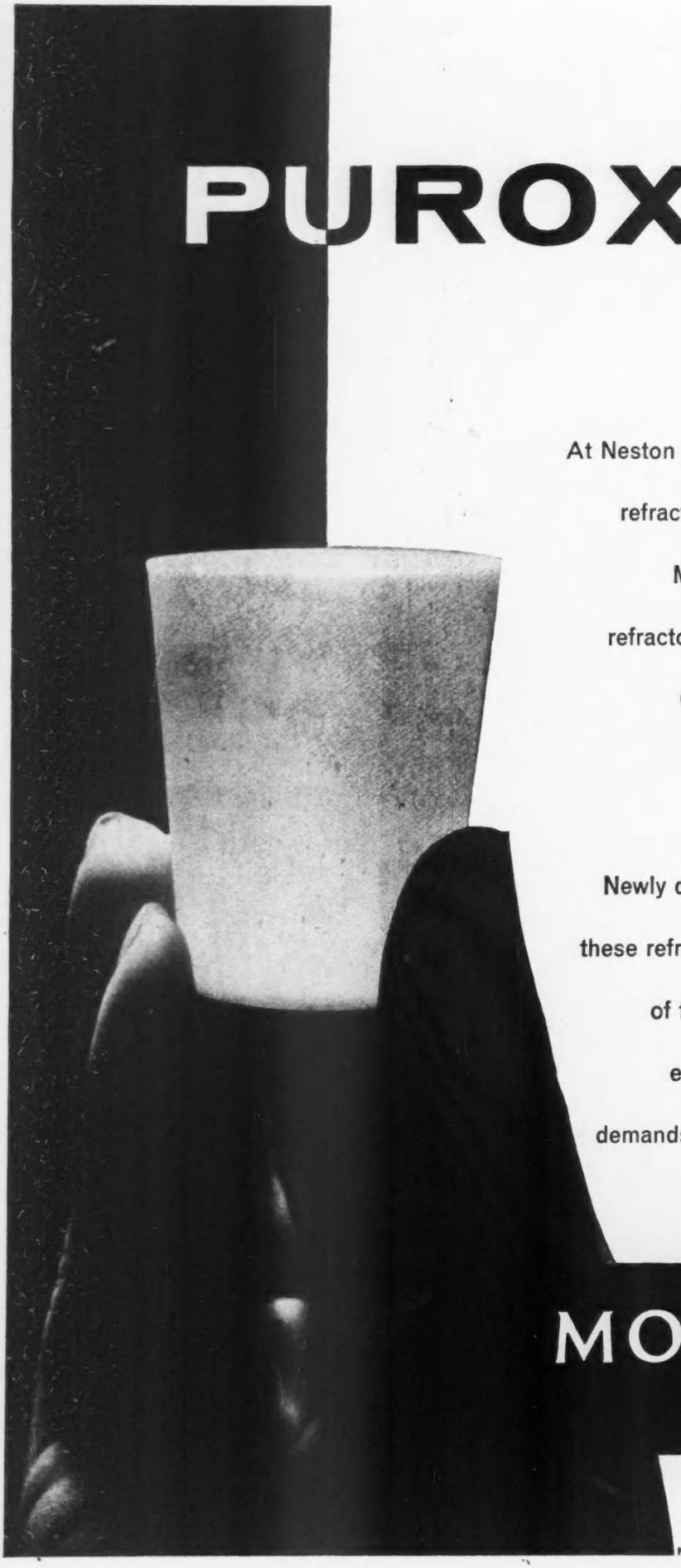

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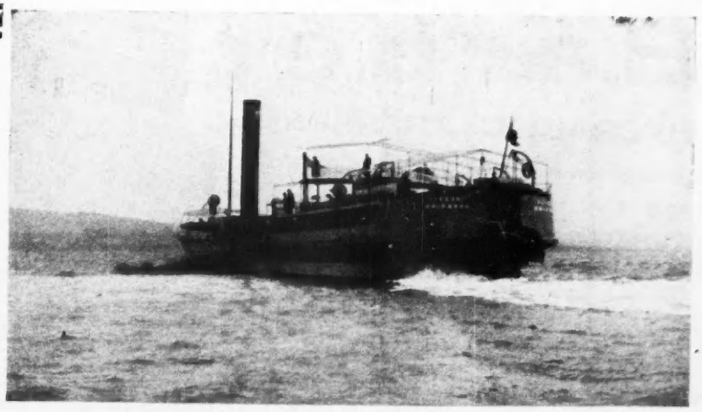

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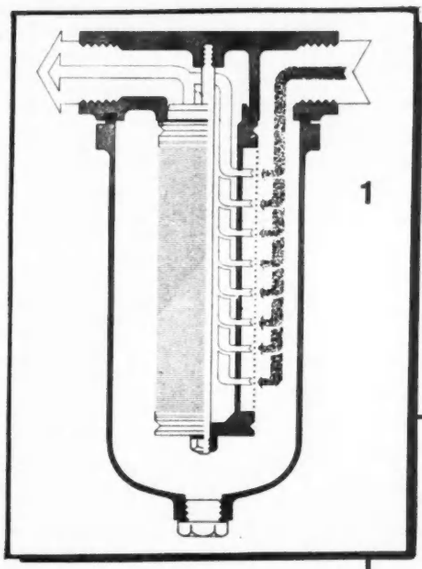


AUTO-KLEAN LOLOS (1)

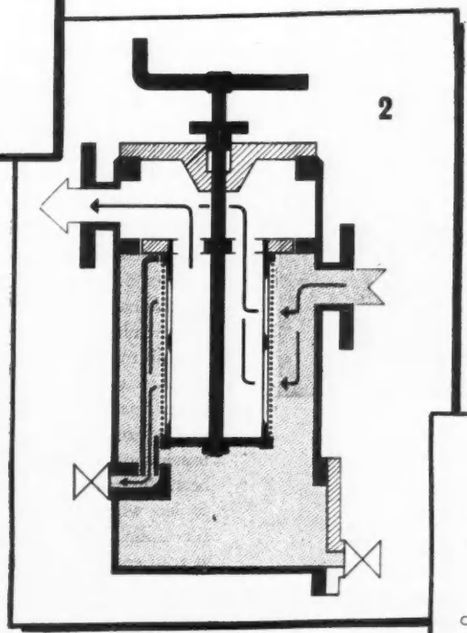
This is a range of filters incorporating wire-wound elements designed for ultra fine filtration of low to medium viscosity fluids under pressure.

Principle: A ribbed cylindrical former is screw cut, and a continuous monel or stainless steel wire is tightly wound into the grooves. By altering the pitch and/or the diameter of the wire defined alterations of mesh can be accomplished. LOLOS L.F. filters have a fabric sleeve fitted over a fine mesh wire-wound element.

Advantages: AUTO-KLEAN LOLOS filters ensure ultra fine filtration *with negligible pressure loss.* Their robust construction remains non-collapsible under extreme pressures, requiring practically no maintenance. Also important is its small lightweight construction.

Data: Working pressures can be arranged up to 2,000 lb/sq.in. Also included in the range are duplex and multi-element designs.

Typical Applications: Hydraulics; fuel and lubrication systems in air, sea and land transport, cooling circuits; distilleries; irrigation lines; washing and bottling plants, etc.



AUTO-KLEAN FLUSHFLO (2)

This is a range of self-cleaning filters specifically designed for continuous operation in the cooling and lubricating systems of heavy machinery.

Principle: Sludge collected by a wire-wound element is dislodged by reverse flow, while the filter element is electrically or manually turned. In contact with the wire element is a spring-loaded slotted tube which acts simultaneously as 'scraper' and discharge passage.

Advantages: The FLUSHFLO is completely self-cleaning while in service without interruption of liquid flow. It ensures fine, positive full-flow filtration with very low pressure losses. And, because the sludge is removed automatically without dismantling, its use leads to reduced maintenance costs. FLUSHFLO filters are also noted for their large capacities relative to size.

Data: Capacities and mesh dimensions fully tabulated in Auto-Klean literature. Quotations on request for processes and capacities not already covered.

Typical Applications: Large scale oil and water cooling circuits; hydraulics; washing plants; water treatment plants; machine lubrication, etc.

AUTO-KLEAN MICOM (3)

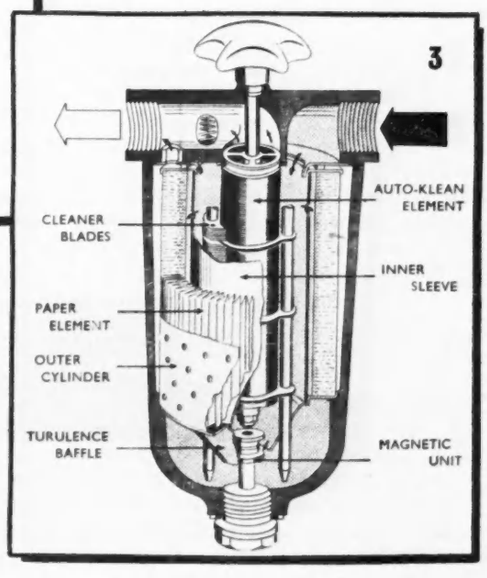
The MICOM combines the advantages of paper as a clarifier with the efficient characteristics of an Auto-Klean, self-cleaning, plate-type element in a full flow filter.

Principle: The greater part of the fluid passes through the plate-type element, while the remainder is filtered by the paper. *The whole of the filtered liquid passes to the outlet side of filter,* thereby giving the maximum protection to the system. A magnetic unit is also incorporated as additional protection against micronic ferrous particles.

Advantages: Positive filtration is guaranteed despite build-up on paper element; paper cannot collapse through choking and therefore its lifetime is increased; constant pressure is maintained as build-up on paper increases . . . while the plate-type filter can be automatically cleaned by turn of the handle—without dismantling. Also important is the low pressure loss and small, lightweight construction of the MICOM.

Data: Working pressures up to 50 lb. sq.in. Can be supplied with ratchet gear for link drive from moving mechanism.

Typical Applications: Ideal for diesel engine lubrication systems of the medium horse-power range and other similar recirculatory applications.



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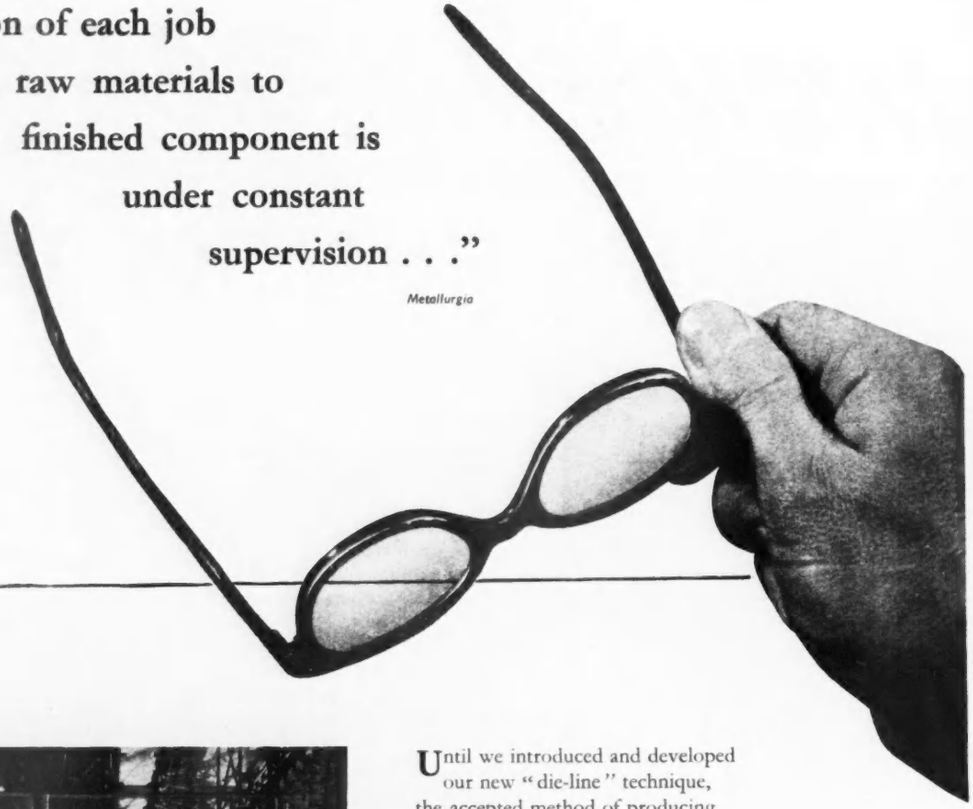
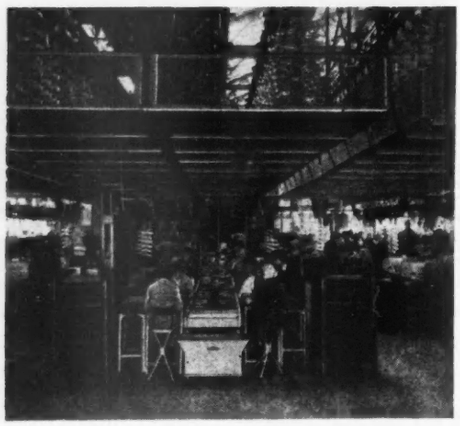
LASCAR WORKS, HOUNSLOW, MIDDLESEX. Telephone: HOUnslow 7722

"production of each job from raw materials to finished component is under constant supervision . . ."

Metallurgia





Until we introduced and developed our new "die-line" technique, the accepted method of producing pressure die castings was by batch production. It involved handling, transit and storage between operations and the risk of damage to critical surfaces—particularly those intended for subsequent plating—was always present. It was uneconomical in floor space and made supervision difficult. All this has changed. The new die-line permits continuous production with all the finishing operations performed on a single conveyor line. Every operation is under constant supervision, and as no casting can touch another, impact damage has been eliminated. If you have a project where quantities are substantial, these facilities are at your service and your enquiries would be welcomed.

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THE ENGINEER

No. 5409 SEPTEMBER 25, 1959 VOL. 208

POLITICAL PROGRAMMES

In these columns, we do not concern ourselves with the politics of any party or sect. But in these days when the Government, whatever its political complexion, exerts so much influence on industry and science, the various manifestos preceding a General Election must be studied. The recently published programmes of this country's main parties contain much that is important to engineers and to industry generally. There are set out in them, for example, promises about the development of nuclear power, improved road systems and water and electricity supplies ; there is emphasis on the need for the further promotion of the country's overseas trade and on the need for a high rate of investment as the basis of raising productivity. Both the Conservative and the Labour parties are evidently agreed about the necessity of an energetic application of science in all phases of economic life, though there is obviously not the same unanimity of thought as to the methods by which that laudable objective shall be pursued ! Nevertheless the same two parties each undertake, if called upon to form a Government, to appoint a " Minister of Science." The Conservative manifesto says that his task would be to promote scientific and technological development and the Labour Party says much the same in rather more words. But, again, both parties pledge themselves to the further expansion of scientific and technological education, an obvious pre-requisite of continuing scientific progress. The only other matter in the party manifestos on which we feel bound to comment is the all-important one of public ownership. The Labour Party insists that the " nationalised industries have played a great part in Britain's post-war development." It goes on to affirm that the " private steel monopoly " must be restored to public ownership in order to ensure its expansion. It claims also that commercial long-distance road haulage must be re-nationalised and built into an integrated transport system. Labour's manifesto then adds " we have no other plans for further nationalisation ; but where an industry is shown, after thorough inquiry, to be failing the nation we reserve the right to take all or any part of it into public ownership if this is necessary." The Conservative Party is equally emphatic. Its manifesto declares " we are utterly opposed to any extension of nationalisation by whatever means ; we shall do everything possible to ensure improved commercial standards of operation and less centralisation in those industries already nationalised . . ." The Liberals, too, in their published programme have a word to say. They call for the cutting out of waste in nationalised industries and Government services and urge that this " traditionally private-enterprise country must pull together to bring about ownership for all " by the encouragement of co-ownership and co-partnership schemes. Thus, the stage is set for the general election, on October 8, which will decide the form of the nation's next Government. The political parties will not, we believe, overlook the fact that their published programmes are now being seriously scrutinised by engineers and industrialists throughout the length and breadth of this land. For the future prosperity of the nation depends as much upon the labours of engineers and industrialists as it does upon the efforts of all the politicians who are anxious to take their places in the new Parliament.

DEMISE OF THE " POPULAR "

Exactly five months ago, we congratulated the motor industry of this country on having added to the variety of vehicles obtainable free of import duty. We spoke too soon. In this issue we have, sadly, to record the demise of a car for which no substitute is to be had, with or without duty. The most immediate sufferers from the discontinuance of the 90in wheelbase Ford are, obviously, the specialist body-builders, for the refined simplicity of this chassis, and particularly the concentration in a few zones of maintenance points to which access must be possible, have long made it the obvious vehicle for the few surviving advocates of craftsmanship and artistry. The less obvious virtues of the design may, however, be missed even more acutely : this inexpensive car shared with a very few designs of extreme performance the ability to meet without manual reversion the legal requirement for effective braking after a single failure of the system—and it also offered a fine ratchet on the handbrake—so that it was the invariable choice for conversion to meet the requirements of many disabled drivers. It met another special requirement posed by the state of British cities to-day : it is worth much to those visiting or living in crowded towns to have unstressed wings and bumpers that can be refinished rapidly. All these features were refinements indeed, but the peculiar needs of a car styled " Popular " were also met : all maintenance not needing special tools could be done with the two spanners in the tool kit, and there was no occasion to jack the car with the handbrake off in order to lubricate universal joints or splines intended to slide. And the insistence of its designer that the attitudes of the wheels should be dictated by rigid links has borne abundant fruit now that steel-cord tyres of great cornering stiffness are available. One can but mourn the classical 2 : 1 proportions of wheelbase and track, observing how the short-wheelbase design enforced by open propeller shafts and Hotchkiss drive is resulting in some recent English cars reverting, to all intents and purposes, to two-wheel braking, to the prejudice of performance on loose and slippery surfaces.

A major contribution to the satisfactory behaviour of this vehicle stemmed from an engine whose excellence tends to be taken for granted, the thermosyphon 1172 c.c. We can reassure our readers here that, because of the insistent need of industrial users for an engine that needs no servicing, other than of accessible ignition and carbura-

tion equipment, and the assured market generated by racing under the 1172 Formula, there is no question of this engine going out of production. Simple as this engine may seem to superficial scrutiny, however, it is very accurately matched to the requirements of a wheeled vehicle, and, it should not be forgotten, could make do with only a three-speed transmission where many newer engines, often larger and heavier and always more expensive, need four. The penalties for failing to consider this matching first and foremost become evident on a casual glance at English cars. As a result, presumably, of taxes on engine size and first cost, the push-rod o.h.v. design has pervaded the English market from the " Best Car in the World " downwards. The narrow working speed range of such engines with a single rocker shaft demands either hydrokinetic transmission or a four-speed gearbox. The resistance of operators to the cost of one and the effect of the other, together with the severe wear of valves and guides expected with the use of rocker arms, has resulted in larger and larger engines being fitted in cars of a given size—the obvious example is afforded by comparing the 850 c.c. front-wheel-drive saloons of Britain, France and Germany. But as long as the carburetter survives, lightly loaded petrol engines must be wasteful, and to mask this defect, compression ratios have been raised. However, the expense of separate valve seats has confined cylinder heads to cast iron, and hence the octane requirements have become formidable. It remains our view that, in this country, road vehicle engines are not really entitled to anything more expensive than regular fuel, since only a small part of their work is done at the high effective pressures that invoke detonation. The push-rod engine promises neither the extreme intervals between valve gear servicing that are desired by the private owner nor the ability rapidly to exchange complete cylinder heads that profits the fleet owner. It offers in exchange the facility of adjusting tappets while idling, which is of value to service stations. When one sees o.h.v. engines installed with the steering linkage passing above the clutch housing, it becomes apparent that the compactness of the side valve unit has been seriously undervalued.

No engineer can fail to ask what can have stopped the career of the " Popular " after production of a mere five-eighths of a million. Body styling is one obvious factor. Presumably it was not possible to redesign the body. A reasonably prolonged study has convinced us that the original mechanical design, now more than a quarter of a century old, is sound enough, though possibly the inclusion of synchromesh in the hope of making it easier to change gear was a mistake. In fact, the synchronising clutches impose strict limits on the energy dissipation during a shift, and therefore render it very difficult indeed to effect a change automatically : certainly, Ford, and other manufacturers, made attempts to achieve this, but it could not be said that the highly complicated systems that resulted were tolerant of unskilled drivers, and they are no longer offered. In contrast, power operation of a dog-clutch base has been proved practical in Germany, even down to motor-cycle sizes of transmission. The limitation, that gear changes demanded co-ordinated movement of clutch, throttle and shift lever, proved serious. But surely that defect alone should not have crippled the car in the protected home market. Some other explanation must be sought. We select one that we have advanced before, the failure to develop a product to its full potentiality. The acceleration available along the axis of the car was increased generously by changing from the 2·23in to the 2·50in bore engine and by adapting to the 10in brakes a compensated linkage particularly easy to adjust. But the distance-covering ability did not improve correspondingly, being limited by the difficulty found by drivers in correcting rapidly enough the errors initiated by side forces and gyroscopic couples—a limitation easy to discover and, it has been proved on the racing circuits, easy to overcome. Again, Ford has now adopted hydraulic clutch actuation, with which the one disadvantage of torque tube drive, feedback to the clutch control linkage, can be completely eliminated, but the marriage of these two sophisticated systems was not effected. Improvements that would have been thoroughly acceptable were continuous lubrication of the rear hubs, neglect of which could prove disproportionately expensive, and roller-bearing steering swivels, many enthusiasts having found that lubrication at intervals as short as 500 miles was reflected in the handling. The responsibility for the loss of this interesting product certainly does not lie wholly upon the engineers concerned, but it is difficult to convince oneself that justice was done to the car by the technical staff. If, as is becoming too obvious to be denied, profit margins are too small to allow completely new cars to be introduced, it is important that existing designs should be developed to the utmost. But, perhaps, taking restyling of the body into account, the removal of the defects from the Ford " Popular " would have added more to its price than the public would have been willing to pay.

NOISE ABATEMENT

Round about thirty years ago there came into being the Smoke Abatement Society through the amalgamation of two smaller societies—the Coal Smoke Abatement Society, founded in 1899, and the Smoke Abatement League, founded in 1906. Neither of the two original Societies had created much stir in the world. Indeed, they were deemed by the nation at large to be collections of people with a cranky notion. The old northern saying, " Where there's muck there's money " ruled the thoughts of most industrialists and also, of course, of those whose money had been placed in industry. Even engineers, who might have been expected to side with the Society—for a smoking chimney is an indication of inefficient operation of a boiler plant—tended to laugh at it because coal was cheap and it was not worth while spending money on suitable instruments to record smoke production or upon training stokers. But see what has come from such unpromising beginnings ! In 1956 there was passed a Clean Air Act. It is, of course, true that there is still much work for that Society—now renamed the National Society for Clean Air—to do. For many years will have to pass before the provisions of the Act can be deemed to have become fully effective. But, at least, there was placed in the statute book an Act unequivocally stating it to be an object of the nation to acquire the blessing of air unpolluted by smoke, laying down reasonable standards and providing for adequate penalties for offenders.

Just recently, there has been created a new Society whose objects seem just about as hopeless of achievement as those of the smoke abatement people fifty years ago. It is called the Noise Abatement Society, and its purpose, according to a manifesto that lies before us as we write, is to eliminate all excessive and unnecessary noise from all sources. Its offices are at 6, Old Bond Street, London, W.1. Of course, there can always be two opinions as to whether any noise is " excessive " or " unnecessary." Even a Beethoven Sonata roaring out of one's neighbour's

loudspeaker can destroy the peace of a hot afternoon in the garden ! So the new Society, besides defining its object, mentions in its manifesto certain matters that it deems call for immediate action ; and others relating to long-term policy. In the first category it lists " to take all possible steps under existing law to protect the public in general, and members of the Society in particular, from assault by noise ; to inform the public by every available means of the dangers of noise to health and pocket, and of their legal rights against those who create noise ; to press for the enforcement of present laws against noise and for new by-laws where existing laws appear inadequate ; to open a branch of the Society in every constituency. In the longer term it intends to press for the " teaching at all levels in schools, national press, radio and television, that noise is ugly, wasteful, unintelligent and unnecessary, and that perpetrators cause suffering and damage to themselves and others." Additionally, it is to campaign " for all new buildings to be adequately insulated and for a quiet room in every home as a retreat from noise or where noise can be created without disturbing others " ; and it claims that " manufacturers of insulation and air conditioners are already busy working out special low prices for mass demand." Finally, it is perhaps its most important object, it will be campaigning for one clear, all-embracing law against noise.

There is, we feel, plenty of room for the new Society. Engineers, unfortunately, are particularly responsible for creating noise. Probably a majority of the products of mechanical engineers are intrinsically noisy ; and a number of electrical engineering products are far from soundless. Prominent amongst creators of noise are jet aircraft, vehicles—more especially the heavier lorries and motor-cycles—and concrete breakers and their associated compressors. But there are many others besides ; and we know of at least one firm which is seriously concerned about the noise level in certain of its manufacturing shops. For most of these things engineers can find remedies. The trouble, however, is that the application of " silencers " to mechanical devices often reduces their efficiency ; which means that the operator, for example, of an engine, must pay an additional sum to have a silencer fitted and then accept thereafter an addition to the running cost. It follows, therefore, that the Society will be asking the community to pay out money to acquire quietness. How much will the community be prepared to pay ? Pessimists will, no doubt, say " Very little." But we wonder. For aircraft operators, railwaymen and the makers of cars all appreciate how highly the travelling public rate quietness within a vehicle. We do not suppose the new Society, therefore, will achieve an immediate and phenomenal success ; but it may be much less than the fifty years it required of the National Society for Clean Air to get the objects of clean air accepted in an Act of Parliament before the new Society gets its " clear, all-embracing law against noise."

GAS INDUSTRY

The construction of a national gas grid within a very few years in this country was forecast by Sir Henry Jones, the chairman-elect and present deputy-chairman of the Gas Council, when he presented the William Young Memorial Lecture to the Scottish Association of Gas Managers last week. The development of such a national grid, said Sir Henry, was dependent upon the use of processes which would enable coal and oil products to be gasified at large works situated at places where raw materials were cheapest. The economic advantages of such a grid are obvious when the savings and improved services which have been made by the introduction of area grid schemes already in operation in this country are considered. With the envisaged large central works supplying non-toxic gas, low in sulphur, to Area Gas Boards at terms for base loads against which local production could not compete in price, there is no doubt that industrial gas sales would extend considerably.

During recent years the increasing cost of carbonisation coal has made the cost of gas production so high that industry has turned to other fuels, and it is understandable that an important object of the Gas Council's research programme is to develop an " all-coal " hydrogenation process for the production of rich gas. Town gas can at present be made at reasonably economic prices from the products of oil refineries, but there is as yet no known method of making town gas, as we know it, by the complete gasification of coal without enrichment by oil or oil gases. With the amount of research now being directed to the development of complete gasification of coal it is to be hoped that a satisfactory economic process will be developed to enable use to be made of the large quantities of poor coals available in this country and make the gas industry less dependent upon supplies of high-priced carbonisation coal and oil, and bring the possibility of a national gas grid a step nearer.

The Engineer—100 Years Ago (SEPTEMBER 23, 1859)

" The Late Mr. Brunel "

" Isambard Kingdom Brunel has passed suddenly from among us, not ripe in years, but at an age at which many men are ready to put forth their greatest power. Mr. Brunel was one of the very few, among the present generation of engineers, whose practice had been co-extensive with the history of railways and of ocean steam navigation, and still fewer of the profession have so distinguished themselves in the grand period of engineering of which the opening of the Liverpool and Manchester Railways was the commencement . . .

" A work, the execution of which attracted much attention, was the railway bridge crossing the Thames at Maidenhead. Partly in consequence of the seeming necessities of the situation, Mr. Brunel determined upon adopting two very flat semi-elliptical arches of 128 ft. 6 in. span, and remarkably enough, he selected brick as the material for their construction. The attempt, bold as it certainly was, was unsuccessful. The work fell more than once whilst in course of construction, until at last it became necessary to form an arch of solid concrete of considerable thickness, over the brick voussoirs, which do not therefore support the structure by virtue of their own resistance as might be supposed. The resources of modern engineering would have supplied Mr. Brunel with means altogether better adapted to the construction of a work in such a situation, although it appears singular that, upon a line, the cost of which was generally so great, the estimates were not slightly increased to include the cost of stone structures, if not throughout, at least for works of such magnitude as the Maidenhead and Wharncliffe Viaducts. The latter, although an extensive work, cannot be accepted as a test of engineering skill, since it involved no especial difficulties of execution, and inasmuch as such works, from the simplicity of their construction, are seldom remarkable for anything more than their bulk and cost . . . ."

S.B.A.C. Flying Display and Exhibition, 1959

No. III—(*Concluded from page* 254, *September* 18)

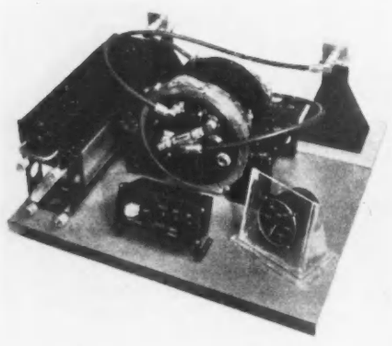
We conclude below our review of the twentieth Flying Display and Exhibition of the Society of British Aircraft Constructors at Farnborough with an account of some of the navigational aids and communication equipment on show during the event.

Airborne Navigational Aids

A DISPLAY by the Ministry of Supply illustrating the "Autoland" fully automatic landing system, developed at the Blind Landing Experimental Unit, R.A.E., Bedford, was supported by individual exhibits of the electronic and other equipment by the manufacturers concerned. In essence, the system (described in our October 24, 1958, issue) consists, on the ground, of two leader cables laid one on each side of the runway and the approach path to it. Magnetic fields from the cables are picked up and fed to the automatic pilot which keeps the aircraft on the runway centre line.

A highly-accurate radio altimeter measures the height above the runway from 60ft and causes the autopilot and automatic throttle control to check the rate of descent and begin the flare-out from the approach path to the touch-down. Automatic allowance is made for the effect of crosswinds. After touch-down, signals from the leader cables may be used to help keep the aircraft straight on the runway.

A complete leader cable system for azimuth guidance was shown by Murphy Radio, Ltd., including the aircraft and ground units. The cables are energised with 250V a.c. at 1070c/s and 1750c/s by an alternator unit. The a.c. flowing in each cable is rectified in a termination box at the remote end and returned as d.c. to a monitor unit, where it is compared with a reference voltage as a check on continuity and insulation. Departure from predetermined limits gives an alarm and lights a lamp showing which cable is at fault. In the aircraft the induced a.c. components are detected and fed to a comparator, the output of which provides



Frequency-modulated altimeter for "Autoland" system

a signal for the automatic pilot. An "S.E.P.2" autopilot gyro unit similar to the autopilot in the B.L.E.U. aircraft featured in the display by Smiths Aviation Division together with the Smiths Flight System (S.F.S.), a form of which is used for visual monitoring of the automatic landing by giving information on the altitude of the aircraft and its position relative to the beam. A frequency-modulated radio-altimeter as used in the "Autoland" system was shown by Standard Telephones and Cables, Ltd. This instrument, shown here, represents the latest development in a range of frequency-modulated altimeter equipment and weighs 30 lb. The transmitter-receiver unit is pressurised and uses conventional valve circuits but the amplifier-counter unit incorporates transistor techniques. A frequency-modulated signal which sweeps through a certain frequency band is radiated by one of the horn aerials and after reflection from the ground is received by a second aerial. It is then mixed with a signal direct from the transmitter, and since a brief interval of time has elapsed since transmission, and hence the instantaneous transmitter and receiver frequencies are not the same, a difference-frequency (or "video" signal) is produced in the mixer. After pre-amplification this is fed by co-axial cable to the counter, where, after further amplification, d.c. voltages proportional to the video frequency are produced. These d.c. signals form the input to the auto-pilot and to height indicators during the approach and landing stage. The instrument can measure heights accurately down to less than 2ft. In order that this sensitivity may not prove inconvenient outside the final approach phase of a loading, the response of the altimeter is damped by rate circuits so that its output of information is not subject to rapid changes by minor topographical features.

A further example of using radio signals reflected from the ground for navigational purposes was seen in the doppler navigator demonstrated on the stand of Marconi's Wireless Telegraph Company, Ltd. The aircraft transmitter in the doppler system operates on 8800 Mc/s and transmits a beam forward and aft at a predetermined angle. Echoes returned from both directions are of changing frequency due to the doppler effect, and a comparison of the fore and aft echoes gives a measure of ground speed. The aerial aligns itself automatically under the control of servo-motors with the actual direction of movement of the aircraft over the ground and so, in combination with the known course, the fundamental data of navigational calculations are obtained.

The transmitter is frequency-modulated in order to assist in discrimination by the receiver between the wanted doppler echo and direct break-through. The received signal is mixed with a sample of the transmitter power and the varous sideband frequencies produced are proportional in amplitude to the delay imposed by the out-and-back transmission. Where there is no delay (i.e. break-through has taken place), the sidebands are theoretically zero. The sideband selected is of a higher order than those carrying noise and vibration amplitude-modulation, and since the doppler effect operates on all components of the transmitted spectrum, the doppler shift in the sideband selected can be extracted by injecting the appropriate harmonic of the modulating waveform at the second detector.

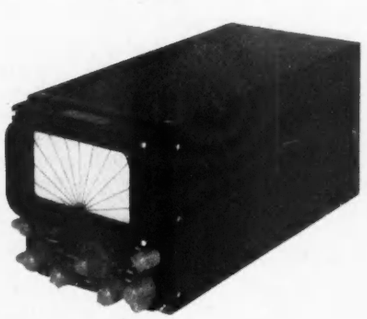
At Farnborough an equipment of the Marconi "AD2300" series was shown working in conjunction with a "4382" computer (opposite), providing the following eight outputs :—Ground speed and drift angle ; wind speed and direction ; present position in latitude and longitude ; magnetic variation ; total miles to go to destination ; miles to go on selected leg being flown ; plan of next selected leg to be flown ; steering information to pilot's direction indicator in flight system (or to auto-pilot). A visual record of the aircraft's progress may be displayed on a roller map with a transverse-moving pointer showing at any moment whether the aircraft is on track or to right or left of it. A device of this type manufactured by Kelvin and Hughes, Ltd., was seen in operation. Facilities are provided in the "4382" computer for resetting the latitude and longitude readings, if these are seen not to coincide with a visual fix, by placing a "run/fix" switch at "fix" and making the necessary adjustments. While this is being done, milage information derived from the continuing flight of the aircraft is stored, and fed back into the counters when the switch is returned to "run."

On the stand of the Decca Navigator Company, Ltd., the Mark 10 Decca Navigator was seen in its new form, consisting of an arrangement of hinged chassis, which allows full examination of the equipment without interrupting operations. The new chassis saves 7 lb in the weight of the equipment, which is now down to 42 lb. Some sixty silicon diodes are used already in the equipment and development now in hand, aimed at further reduction in size by a factor of 2, will necessitate extensive replacement of existing valves by semi-conductor devices. If experience shows that certain functions are performed more reliably by valves than by transistors, sub-miniature valves will be used. The characteristic of the Mark 10 system is the transmission by the ground stations three times a minute of harmonics of their normal frequencies, which are added in the receiver to produce a pulse waveform with a recurrence frequency of $1/f$ (i.e. the fundamental). The pulse remains within the phase limits required for lane identification even in the presence of very large shifts in the relative phases of its four components, such as can occur at night-time on the fringe of the chain coverage.

A system for transforming position and route information received from ground stations into a tracking signal output suitable for direct application to a flight director system or automatic pilot, was shown by the Sperry Gyroscope Company, Ltd. This is known as the Sperry Radio Track Guide, and consists essentially of an airborne analogue computer of simple design, weighing about 50 lb and having a volume of 1 cubic foot. The guide can be used in conjunction with any aid which provides continuous and accurate fixes in two co-ordinates. Considering an aircraft at point *A*, which is to fly a straight track to *B*, the point *B* co-ordinates are fed in and cause two potentiometer wipers to be displaced, proportionally to the co-ordinate differences. A tracking meter is connected between the wipers and the voltages across the potentiometers are adjusted to be zero. Any subsequent reading on the meter during the flight will indicate a displacement from the track. Indications may be presented to the pilot in the form of lateral displacement and distance to go. Ground and air trials have been conducted

in Europe using the Decca chain, but the system is equally applicable to other ground-based aids using two co-ordinates such as Loran C, Gee, Dectra, Vortac, and so on.

A new transistorised airborne weather radio weighing only 56 lb was shown by Ekco Electronics, Ltd. The design features which have made this saving in weight possible include incorporation of the synchroniser circuits in the scanner and indicator units, instead of installing them as a separate rack-mounted equipment. An installation therefore consists of three main units. In the indicator (below) the use of a rectangular tube has enabled all operational controls to be mounted on the front panel so that a separate control unit and its interconnecting cables are eliminated. All the timebase generation and the main I.F. and video amplifiers are in the indicator, so that in dual indicator installations independent control of timebase range and I.F. gain is possible. A further contribution to reduced weight and space is a lower transmitter power of 15kW instead of 60kW as in previous equipments, which, in conjunction with the use of transistors, has reduced the total power input to 300VA, but the resultant decrease in system gain has been compensated by the use of a longer transmitted pulse, improved noise factor (derived from recent improvements in microwave crystals), and higher antenna gain. The range is 150 miles. A duplexer incorporating a ferrite isolator is incorporated in the transmitter-receiver unit to prevent pulling of the magnetron by radome reflections or waveguide defects.



Indicator unit of new airborne weather radar, incorporating control panel under the 5in by 3in rectangular tube

This type of lightweight search radar is being installed in the "Vanguard" aircraft under construction for B.E.A.

Ground Navigational Aids

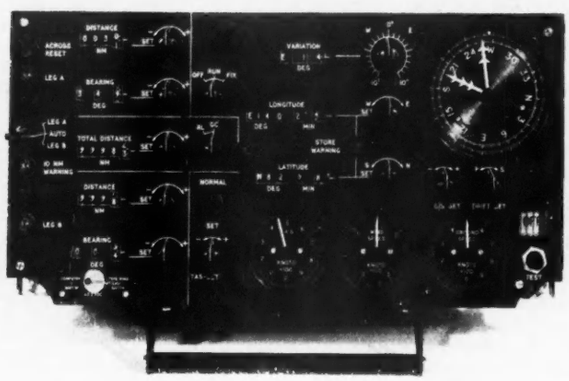
Equipment shown by Decca Radar, Ltd., included a new height-finding radar, "HF200," the aerial structure of which is illustrated. Slewing and nodding movements are controlled by an oil-hydraulic system producing a linear vertical sweep, with the ability to nod while slewing. The angle of nod is limited automatically when the equipment is measuring the height of an aircraft at long range to avoid scanning unwanted air space at high angles of elevation. A range in excess of 275 miles and heights of above 75,000ft are claimed. Information may be fed to several operators, who may select different targets and have them dealt with in turn.

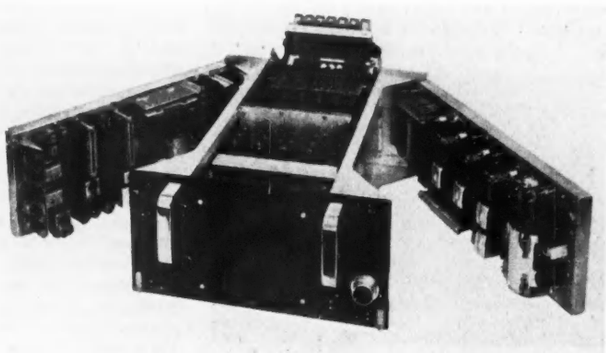
Development of airborne navigational aids has not diminished the importance of the v.h.f. direction finder, which can serve aircraft fitted only with the simplest forms of communication equipment. Standard Telephones and Cables, Ltd., demonstrated a cathode-ray tube bearing display indicator on which the bearings of two aircraft can be shown simultaneously, the traces being differentiated by appearing as solid and broken lines. The equipment operates on a time-sharing system based on multivibrator circuits. We understand that increasing interest in v.h.f. direction finding is becoming evident in the United States as a result of the growing air traffic control problem presented by private aircraft. An automatic v.h.f./d.f. equipment giving instantaneous bearings on a 6in cathode-ray tube, and employing a simplified rotating aerial system, was shown by Ekco Electronics, Ltd.

Visual aids supplementary to electronic systems for landing were represented by a visual glide path projector unit, shown by Thorn Electrical Industries, Ltd. This device is used in the R.A.E.-Thorn visual glide path indictor system, which has been developed at R.A.E., Farnborough, and is being evaluated operationally at London Airport. Projectors form bars at or near the limits of the desired touch-down area. These projectors emit red and white signals which define a corridor bracketing the electronic glide path. The principles of such a system were described in our August 22 1958, issue, page 291.

The projectors consist basically of a flat rectangular box with a slit in the face presented to the approaching aircraft. The light sources emit beams which converge in the vertical plane, the cross-over being at the slit. Just in front of each light source is a red filter covering the upper half of the converging beam. As a result the diverging beam emitted by the projector is red in the lower half, and white in the upper half. The absence of a lens means that there can be no colour mixing due to condensation or frost on the surface of the lens.

Thorn Electrical Industries, Ltd., has reached an agreement to take out a licence with the holders of the British patent, the National Research Development Corporation, for commercial manufacture of the glide path indicator projectors. Development work jointly by the R.A.E. staff and Thorn Electrical Industries, Ltd., has resulted in an improved design, the subject of a further patent specification.

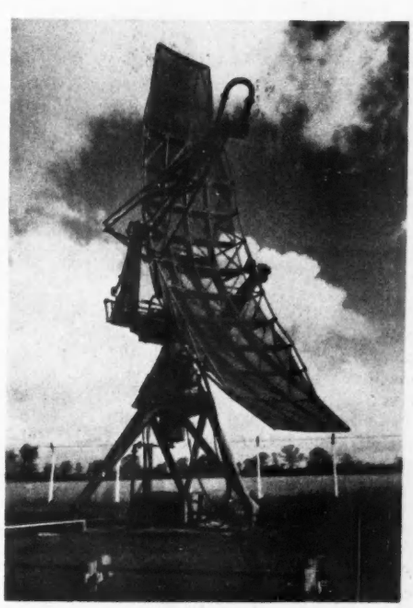




(Left) Control unit of doppler navigator computer with direct presentation of position, distance run and other navigational information. (Right) Hinged chassis construction of the latest "Decca Navigator" receiver

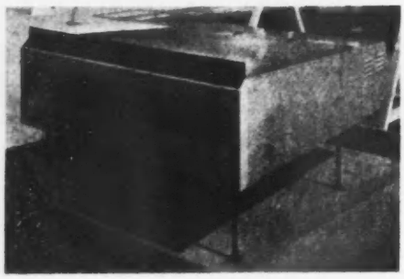
Communications

The very wide range of ground and airborne communications equipment exhibited illustrated the general move towards higher frequencies and towards making still more use of those already carrying air/ground traffic. In connection with its "A.R.C.-52" v.h.f. ground-transmitter/receiver, the Plessey Company, Ltd., featured a simple modification to adapt it for 50 kc/s channel spacing. Redifon, Ltd., showed a series of equipments using independent and single-sideband



Aerial system of long-range height-finding radar

techniques, based on unit construction to enable installations to be expanded in step with increasing demands. The 1kW transmitter used by Pye Telecommunications, Ltd., in the moon reflection experiments last Whitsun is now being produced commercially as the " PTC 3600 " for airport ground station use. This is basically a two-unit equipment, the r.f. and modulator sections being assembled in separate cabinets which are combined into a composite equipment for r/t service. Frequency range is 118–136 Mc/s, and while intended normally for single-channel operation, it can be set up on any frequency in the above range in a few minutes. In



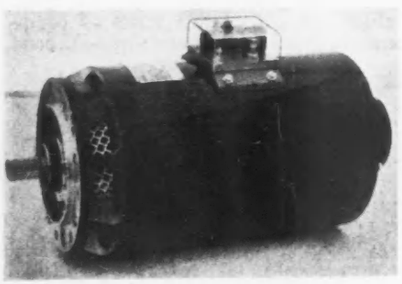
Visual glide path indicator emitting red or white signals according to altitude from which observed

the course of tests to date, reliable two-way communication with aircraft at a range of 450 miles over the Atlantic has been obtained.

Airborne teleprinter equipment was again in evidence, and the transistorised equipment shown by Marconi's Wireless Telegraph Company, Ltd., was seen connected to a loop aerial from which omnidirectional reception is obtained by suitable design of the receiver circuits, while the effects of precipitation static are minimised by the loop characteristics.

Electrical and Test Equipment

Of the many examples of aircraft electrical equipment, the brushless d.c. generator shown below is of interest as a further



Brushless generator giving 9kW, 30V direct current over the speed range 5000 to 8000 r.p.m.

development by The English Electric Company, Ltd., on the same lines as the company's earlier alternator. In the 9kW d.c. machine illustrated, an auxiliary rotor revolves in the field of a stator excited at low power from the final output, the automatic output control being effected at this stage. The a.c. so generated is rectified by rectifiers on the shaft and excites the rotor of the main alternator portion. Thus a.c. is taken from the main stator and is rectified for delivery as d.c. to the output terminals. All rectifiers are silicon and are air-blast cooled by the normal cooling of the machine. The complete unit weighs 30 lb.

A novel development in oscilloscope practice was seen in the " QD910 " instrument shown by The Solartron Electronic Group, Ltd., which incorporates a " Memotron " storage tube giving infinite persistence while a subsidiary " flood " electron gun is in operation. While the writing gun is switched on, a storage mesh with a high secondary emission coefficient loses more secondary electrons where it has been written on than it gains primary ones. It therefore acquires a positive charge corresponding to the written pattern. Electrons from the flood gun are attracted to and pass through these areas, so reproducing the pattern on the viewing screen, at the same time maintaining the positive charge pattern on the storage mesh by releasing further secondary electrons. Eventually the storage mesh stabilises at the potential of the secondary electron collector mesh mounted behind it. To erase the picture, the collector mesh potential is lowered and secondary electrons fall back on to the storage mesh, cancelling its positive charge.

In addition to its general display of aircraft and airport equipment, The General Electric Company, Ltd., showed several examples of the work of its Applied Electronics Laboratories in remote control, guidance and monitoring techniques. Among these was a missile attitude indicator developed for G.W. Department, R.A.E., to measure the attitude in roll, pitch and yaw of a " Skylark " research rocket during flight. Two high-power c.w. X-band transmitters are stationed on either side of the range centre line to illuminate the rocket. A special bay in the rocket, mounted on a strong ring, contains the circuitry and three flush-mounted microwave aerials, arranged to form two orthogonal interferometers. The microwave circuit is almost entirely contained in the strong ring.

By a phase comparison technique, the angles between each interferometer base line and each transmitter are measured. Any three of these four angles can be combined with the knowledge of the rocket's position in space to determine roll, pitch and yaw to within a few minutes of arc. The interferometer measures the phase difference between signals received at two aerials from a single source.

The G.E.C. system avoids the difficulty of maintaining equal phase responses in two amplifier channels. By means of a microwave single-sideband modulator, a low frequency ω, is added to the local oscillator input to one mixer. The frequency and phase differences are preserved during mixing and, after adding the two signals, subsequent amplification is in a common intermediate frequency amplifier. After detection and further amplification, the resultant low frequency is compared in phase with a reference frequency ω, derived directly from the modulator, to give a voltage proportional to the phase difference existing at the receiving aerials. This is then telemetered back to the ground.

British Association at York

No. II—(*Concluded from page* 256, *September* 18)

We were represented editorially at a meeting of the British Association for the Advancement of Science held at York between September 2 and 9. No attempt is made in this article to summarise all or any of the very many papers of interest to engineers presented at the meeting. Instead the article consists partly of quotations from, and partly of our comments upon, a number of the papers. The intention is to suggest to the reader how mentally stimulating attendance at a B.A. meeting can be.

Fear of Science and Technology

LET us turn now to Section X; and let us shift away from transport. Those who belong to Section X (Assembly of Corresponding Societies) can, rather broadly, be taken to be people with no scientific training but with a thirst for scientific understanding. In her address to the Section this year, the Countess of Albemarle, the President, referred to them as people who " have been existing, not living with science," but who have realised it is time they became " fully conscious." She also remarked " I think many of us are shaken and uncertain in our innermost being by what we imagine is the threat of science to our beliefs and our sense of personal worth. . . . . ' I, a stranger and afraid, in a World I never made. . . . . .' This fear, often unconscious, can act as a block in our minds and stop us from seeking to learn about the discoveries of science." That harks back to the remark of the President of the Association in *his* address, that " the discoveries of physics *have* frightened mankind . . . . . there are far too many intelligent people looking askance at science and wondering where it is leading."

It is, we suppose, one of the objects of Section X to bring such fears out into the open, where they can be the better examined ; and another of its objects must be to express to scientists some of the thoughts of intelligent laymen about the applications of science. If we are right, then Mr. Ritchie Calder, in presenting a paper before that section on the " Use and Mis-Use of Science," kept well within the objects of the section. We confess, having listened to him, and having read a summary of what he says he said, that we are not quite sure upon which side of the fence he stood or whether, perhaps, he aimed to maintain a precarious balance ! But what he clearly did was to express many of the fears of the layman about the " mysterious " workings of science. Some are justified, some arise from misconception. One in the latter class is a fear amongst laymen of the computer. Mr. Calder mentioned a personal experience of listening to the deliberations of some designers and makers of computers when they spoke of " memories " capable of absorbing all the knowledge in the British Museum (and a good deal else besides), and of machines capable of doing calculations beyond the bounds of human possibility, and of other machines capable of exercising choice. No doubt to laymen it all sounds alarmingly like the eventual construction, quite soon, perhaps, of brains more " perfect " or more " capable " than human brains, but, of course, quite inhuman—something like the " Great Brains " in that book by Olaf Stapledon, *First and Last Men*. They would be immensely comforted by

contact with those who have to operate computers rather than design them ; for *they* regard computers as utter morons ! The truth is, of course, that, as with machine tools capable of performing operations which man could do by hand only at great expense of time and labour, so with computers, one can get out of them only what they have been instructed by a human mind to provide. They are merely labour saving, even if some of the calculations they can do with speed and precision would absorb so immense an amount of human computation by conventional methods that no one would consider the effort worth while. In this connection it is curious to recall that between the wars, when mass-production methods were being widely adopted in industry, there was amongst laymen a not dissimilar fear that somehow men might lose control of machines and become slaves to them. Does anyone still feel that fear ? Perhaps some do. For they cannot help feeling it is degrading to put a human being to a repetition task. Why, in Heaven's Name, do young girls regard such tasks—we saw some at work in a factory we visited on one of the excursions—as less degrading than domestic work ? Are they not slaves to the machine ? Have they not sold their souls for the mess of potage represented by high wages ? The answer is, " apparently not ! " For outside the factory they are gay, vivacious, well-behaved and normal.

Then Mr. Calder claimed—or so we thought—that scientists could no longer disclaim responsibility for the uses to which their discoveries were put. It has been suggested in support of this argument that scientists can no longer plead that they are innocent accessories before the fact whose discoveries have been perverted by others, since the day when they themselves proposed to the Government the release of atomic energy in the form of a nuclear bomb. But is it not a *non sequitur ?* Mr. Calder himself pointed out that scientists, aware of the implications of their researches, have a duty to the public to share that awareness. Surely their responsibility over the atomic bomb was adequately acknowledged when they pointed out the potentialities of the splitting of the uranium nucleus to the Government. It was after that the Government, not the scientists, which decided the bomb should be made. Incidentally, in the last resource, of course, it was engineers, not scientists, that made it ! Indeed, if there is any villain at all in this piece, scientists could reasonably claim that it is not them and that they cannot consent to being made scapegoats for what engineers do—no doubt with sinful commercial thoughts in mind—at the behests of evil-minded customers ! Indeed it cannot be denied that the public does have some reasonable grounds for fearing what engineers may do. For it is seldom possible to foresee all the effects of applying a scientific discovery ; life is too complex. In a paper on " Coast Erosion and Protection," in Section E (Geography), R. Gresswell remarked, for example, that the erection of a sea-wall at Blackpool had caused serious erosion at Fleetwood, near by. " When Nature is interfered with at one point, this often sets in motion a whole train of subsequent events, some of which may even be more disadvantageous than the trouble which the interference was intended to cure." What one can do is take all the care that limited human foresight suggests, have faith in the ability of man to find correctives for any harmful consequences and courageously make a trial of the outcome. Engineers have for centuries been building all kinds of structures in woeful ignorance about some of the prime factors involved. By trial and error they have learned what is and what is not good practice long before the acquirement of more complete knowledge has permitted designs to become refined. Unless man has the courage to apply that " little knowledge " which is admitted to be a " dangerous thing," then his rate of advance to the acquirement of yet more knowledge must be sadly delayed. The public surely has the right to be told about the dangers of particular experiments—as with the radiation dangers from the development of nuclear power, or the equally disastrous possibilities (so we learned at York) of the application of emergent biological knowledge. It has, too, a clear right to demand that certain experiments shall not be undertaken ; there is, for example, already a hope that no more atom bombs will be exploded in the world except, perhaps, for well-defined utilitarian purposes. But in general any nation that refused to take the risks inherent in the application of new knowledge would be condemning itself to become backward. The moral to be drawn is surely not that any hindrance should be placed in the way of scientists or those, like engineers, who apply science ; but that in any body directing the work of others or choosing for them, whether it be a board of directors, a local government committee, a council of an association or a cabinet, there should be at least one member of it fully " seized " of science and others with at least some understanding of it. If we understood her address to Section X aright, that is very like something the Countess of Albemarle said. We feel encouraged that our conclusions should be so like hers.

An Economist's View of Science

But, after expressing, in effect, so much confidence in science and particularly applied science, we feel we ought to take the reader at once to Section F (Economics) and to the address Professor John Jewkes presented to that Section. For he examined the common tendency to-day to argue that the United Kingdom produces too few scientists. Upon what basis is that argument based, he asked. It proved a very pertinent question. For he could find no sure ground on which to base it ! He examined the point on the lines of the making of international comparisons (" recent international comparisons of the scale of scientific effort must rank among the most reckless of all statistical exercises ever made ") ; the correlation between industrial output and the number of scientists and technologists ; inter-industry comparisons (others besides Professor Jewkes have pointed out the uncertainties in that line of argument) ; and the measurement of the net gain arising from research and development (. . . . . " although there has been an enormous increase in the United States in the sums expended on industrial research and development since 1930 . . . . . there does not seem to be any strong evidence that this has made steeper the general upward trend of output per head ").

Now all this would be highly stimulating —for it is always stimulating to have one's ideas challenged, particularly when one has assumed them to be well founded. But unfortunately Professor Jewkes went on to make certain remarks that suggest a strange prejudice, not against scientists, but against the application of science. For example— " Whilst no one would wish to deny that technology and science (in that order) have contributed much to the raising of standards of living in the last two centuries, there is a disposition in these days to exaggerate the contribution they have made and to underestimate that made by new social organisations and institutions. New ways of collecting capital for investment ; new systems of controlling currency and banking ; new market organisations for bringing goods and services to the right places at the right times ; new conceptions of the virtues of free trading ; new legal codes and systems of arbitration enabling trade to be carried on more securely and more speedily ; in their totality these social discoveries may have contributed just as much as the technical inventions and scientific discoveries of the period." But is this not to place the cart before the horse ? Were not these things made necessary by technological advances ? Again " Much loose talk about ' the second industrial revolution ' is leading us to overstress the potential material benefits of recent scientific discoveries. Atomic energy, to take the most spectacular case of all, must still rank as a very heavy debit item in this scale. For, as a result of it, fearful peoples everywhere are sacrificing their standards of living for the purpose of creating modern weapons of war or systems of defence against them. As for the peacetime uses of atomic energy, all that we have are promises, which in recent months have become increasingly tentative, that at some unidentified future moment electricity will thus be generated at a cost as low as the present cost of producing electricity by burning oil or coal under boilers." This seems to be just about as prejudiced as any talk of the opposite kind. Finally it is surely an " assertion," not as Professor Jewkes claims " an observable fact," that " the overwhelming mass of scientific thought and observation in the Western world was never designed to bring, has not brought, and is highly unlikely ever to bring the slightest improvement in material standards of living. This, of course, is not a confession of failure. It is simply one way of asserting that the ultimate purpose of science is not to cater for the lower claims of material progress, where indeed its yield is uncertain, fluctuating and sometimes even negative, but to satisfy the higher needs of knowledge for its own sake, where its returns can hardly ever fail to be positive." In this day the use of the word " lower " is surely astonishing ; and for Heaven's sake ! was not enough harm done to art and science by the arid and out-of-date doctrine of the superiority of art for art's sake ? Must we now have an equally arid doctrine of the superiority of science for the sake of science over the application of science ?

More Human Aspects of Science

Practical men in an engineering works sometimes complain that all the high-faluting chaps from the laboratory seem able to do is to discover the obvious ! There is a grain of truth in the complaint, too. For, in the early stages of a study research workers are concerned very largely with the gathering of facts so that they do appear to be discovering what everyone knew all along. Judged by that standard, the whole science of psychology must be at an early stage of development. For, in reading the address to Section J by Professor Vernon, most people who have had any experience in " managing " others and who have indulged in a little introspection will be inclined to say that the psychologists are discovering nothing new at all. Those who attended the Lister Lecture by Dr. Broadbent may well have reached a similar conclusion. But, of

course, just as with the complaints of practical men about engineering research workers, a half-truth is involved. When scientists gather facts they want to do so with precision; and, above, all, they want to be sure that they really are facts and not merely impressions. Thus, one can take a sentence or two from Professor Vernon's address and chuckle a little to find that something so obvious is so earnestly put down. For example, "If observers are instructed beforehand to attend particularly to one aspect of a complex field—a field, for instance, which contains numerous types of shape of different colours—they will report this aspect with greater accuracy than if they had not been so instructed. But they will be more likely to overlook the other aspects, and be able to report very little about them." But what is important is that this quality of the human mind and many other qualities besides to which Professor Vernon drew attention have been established as realities and, in a sense, been given numerical values, since each conclusion is based upon a statistical evaluation of the reactions of a number of observers. Professor Vernon, in fact, knows with greater precision than laymen what he is talking about.

Yet we cannot help wondering how much of value is likely eventually to come from such work. The practitioners of mass-advertising may well be delighted to be given statistically correct information about the reactions of human beings in the mass to various stimuli. But the executive in an engineering works wants to know how to handle each of his juniors. As it appears that the individual reaction to a stimulus may diverge widely from the statistical average, it does not seem likely he could learn much at present.

From mind to body—to Section I (Physiology and Bio-Chemistry). There was presented to this Section by A. D. Munrow an entertaining paper on "The Application of Mechanics to Physical Skills and Activities." It is really very remarkable with what innate skill a human being can use his body to propel an object through the air, or strike it with a bat or racket or a club, so that it goes in a desired direction with or without some amount of spin; or to project his own body in one direction or another. For ourselves, we are constantly amazed when watching people using their muscles at the innate ability of ordinary men to distinguish between accelerations and velocities and to use the principles of the conservation of momentum and so on. Munrow and his collaborators are studying this subject; and we can agree with them that "it is surely intellectually satisfying, and even exciting, to understand these things." But they seemed a little pessimistic in assuming that "it is not likely that theoretical considerations will predict new and better techniques." All engineers know how useful it is in learning a new bodily skill—to use a file, for example, or to ride a bicycle or to cast a fly—how useful it is to have some mechanical conception of what it is that the body must do. Is it wholly impossible that a better mental understanding, such as Munrow is seeking, should improve actual muscular performance? Furthermore, a better understanding of the mechanics of the matter—we write now with some authority as engineers—ought certainly to mean that at least the implements of any sport can be better designed to suit their purposes.

Education

Often at British Association meetings much that is presented before Section L (Education) is of deep interest to engineers. This year, however, was somewhat of an exception because stress was being laid on education in the schools rather than at universities, technical colleges and within industry. We do not feel very competent to comment very much on that aspect of education. But anyone who feels that on the whole there is not much wrong with it should read the address by Sir James Robertson, president of the section. What he had to say may well come as a shock to them. He asked, among other things, why only a small minority of British adults continue their general education after leaving school. He answered damningly: "Because whatever the schools have achieved, they have not so commended their wares that the customer keeps coming back, once he is free to stay away." He suggested two reasons. "By clinging to a curriculum too heavily bookish in content and too rigorously intellectual in its demands, for all but the ablest few, we subject the many to a repeated experience of failure or at least of insufficiency, which goes far beyond anything that later life will normally bring them. Is it sentiment or softness, and not just common sense, to hold that the effect of such a classroom experience on ordinary bairns must be to dishearten, kill interest, and create a determination, whether conscious or not, to give education a wide berth, once school has been left behind?" The psychologists, as a reference to Section J revealed to us, have, indeed, shown that repeated disparagement makes it increasingly difficult for any human being to be taught a task. May we quote just a few more sentences from Sir James, "the obverse of excessive demands on the intellectual side is comparative neglect just where the generality of children could do something and enjoy doing it, namely, in the spheres of feeling, taste and activity. Admittedly, there has been improvement here in the past twenty years, but we still deny to music, drama, and the visual arts (surely the very stuff of further education for most men and women?), the sufficient place in school that would ensure their place once school days are past. Note, too, that this has a social as well as a personal significance, for the Scottish Advisory Council was right in claiming that it is through constant participation in such activities rather than by a severely intellectual process that the mass of human beings come to feel themselves part of a culture and sharers in a national inheritance."

Curiously, perhaps, one other educational reflection was suggested to us when we listened, in Section G, to Mr. H. G. Conway presenting a particularly interesting paper (illustrated by films) on "VTOL; an Aeronautical Challenge." VTOL, it may be as well to explain to any reader unfamiliar with aircraft development, stands for Vertical Take-Off and Landing. Short Brothers and Harland, Ltd., of which Mr. Conway is a director and chief engineer, has in existence a research aircraft which can be supported by jet-lift engines and which is designed to study the problems arising in the transition from jet-supported to wing-supported flight. At an early stage it was discovered that the problems of maintaining stability in hovering flight by use of the controls were more difficult than an unaided pilot should be asked to solve. There had, therefore, to be devised a kind of automatic pilot able, not to fly the aircraft, but to give it a kind of temporary stability so as to give the human pilot time to recognise impending lack of stability and to take the necessary action. But what it may be asked has this to do with education? The point it seems to us is that the problems professional engineers are being asked to solve nowadays are very different from those they had to solve forty or fifty years ago. Nowadays they have to apply techniques of mathematical analysis to the solution of problems and for the improvement of design. Half-a-century ago practical "rules of thumb" played a major part in design and production and problems were usually solved by "trial and error." On the production side, fifty years ago men on the shop floor had still to be convinced that manufacture of interchangeable parts was possible and the managerial side had to be convinced that it was economic. Nowadays almost any shape of part to almost any standard of accuracy can be produced by well established methods in any ordinary engineering material by any properly equipped workshops. That can be taken for granted. What, therefore, the professional engineer needs to study on the production side is how best to secure economy in production costs. The distinction is surely important. He is hardly at all concerned how to produce an object; he needs to study how to produce it most cheaply.

The consequence of the change is that ideas about the practical training of graduates are also changing. On a visit to the Wilton Works of Imperial Chemical Industries, Ltd., for example, we noticed that the emphasis in graduate training is no longer upon the acquirement of handicraft skill as it used to be half-a-century ago but upon analysis of problems and the basing of design upon such analysis. In the apprentices' "school" each graduate, we gathered, was required to undertake the design of some piece of equipment and then, in conjunction with apprentices, acquiring handicraft skill, to make it. Fine training we would say.

Space

We cannot close this account of the B.A. Meeting at York and our discursive comments upon it without reference to one other subject. What a pity the Russians did not secure a direct hit on the Moon a few days earlier when the B.A. Meeting was still in session! It would have created a mighty stir! However, the meeting was not without papers of interest to "rocketeers." There were no less than five concerned with one aspect or another of propulsion in Section B (Chemistry) though no point seemed to be brought out that has not already been brought out elsewhere. The following may prove illuminating to engineers not wholly familiar with this field. Experience to date has been that solid propellant rockets are very reliable and they can be produced at reasonable cost, but to enable them to be used in the larger missiles, methods of thrust control and thrust termination, will have to be developed. For liquid propellants problems of safety, toxicity and cost may have greater significance than pure performance criteria and any realistic development programme should accept the chemical limitations and achieve higher performance by adopting the technique of propulsion staging. Intrinsic chemical energy is not by itself a satisfactory guide in the choice of propellant. Generally attempts to increase the efficiency of the system are more rewarding than the use of highly energetic propellants in a less efficient system. Military applications can be met by the use of conventional propellants and they are adequate for putting satellites into orbit. The most spectacular advances in recent years have arisen from substantial

increases in the size of rockets and the weight of propellant carried ; the perfection of multi-stage rockets ; and the development of very large solid motors containing up to 10 or more tons of propellant. Much higher performances, not obtainable with chemical systems, are required for controlled flight in outer space.

Lastly there were two papers in Section A (Mathematics and Physics). The first related to "The Figure of the Earth and the Orbits of Artificial Satellites." It will interest surveyors to hear that because satellites can be observed so accurately and because the effects of the polar flattening on their orbits are so great the flattening can be found about twenty times more accurately from three satellites than from all the measurements that have gone before!

The other paper on this subject related to "Results Obtained from the Study of Satellite Orbits." One of these results is that at heights between 120 and 240 miles the air density falls from 4·8 lb to 0·08 lb per cubic mile. These figures, which refer to the average value, are between four and ten times greater than was previously believed. How astonishing! The temperature—about 700 deg. Cent.—is also substantially higher than was believed. There appears to be a strong west–east wind at heights between 100–150 miles. Besides indicating the average air density, satellite orbits have revealed clearly the variations in density. The results here are also unexpected. The air density does not remain for long near its average value ; it fluctuates widely, and during 1958 peak values of density occurred at intervals of about twenty-eight days. The density departed from its average value by up to 30 per cent at 150 miles height and up to 50 per cent at 400 miles height. The twenty-eight-day cycle suggests control by the sun, which rotates, relative to the earth, once every twenty-seven to twenty-eight days, so that any streams of particles shooting out from a particular part of the sun tend to swing across the earth at intervals of about twenty-eight days. The upper atmosphere therefore seems to be strongly under the control of solar disturbances, though the exact mechanism of control is not known.

How long will it be we wonder before a B.A. paper gives some particulars of the reaction of a human being to space-travel ; and how long before photographs are published from ground level of the surface of the moon ?

Lighting of Kai Tak Airport

The airport lighting system of the new Kai Tak airport, Hong Kong, is briefly described here. This lighting, together with modern landing aids, is designed to make the airport fully operational for large aircraft, twenty-four hours a day, even in bad visibility. The approach to Kai Tak airport is restricted by hills to the north ; the north-west approach is served by a lighting system which includes a 3510ft long curved section ; the lights for the south-east approach are carried on piles driven in the sea bed. Design of the lighting system was carried out by Preece, Cardew and Rider, for the Hong Kong Department of Civil Aviation.

A SPECIAL lighting system has been installed at Kong Kong's new airport, Kai Tak, which is intended to handle large modern aircraft and to be fully operational twenty-four hours a day, even in bad visibility. Because of the limited radio and visual aids the old airport, built at the foot of the Kowloon Hills, could only be used from dawn to dusk and in relatively good visibility.

The first stage in the development of the new airport went into service in September, 1958, with the opening of a new runway (Figs. 1 and 2), 8340ft long, laid on a 795ft wide artificial promontory which was built to avoid encroachment on Kowloon city, where space is very valuable. Since the Lion Rock hills preclude direct aircraft approach, the north-west approach lighting system (to runway 13) includes a curved section (Figs. 1 and 2), which is 3510ft long and is believed to be only one of its kind in the world. For the south-east approach (to runway 31) the required lights are carried on piles driven into the sea bed, as illustrated in Fig. 3.

Aircraft approaching from the west start their let-down procedure over the West Lamma Channel between Cheung Chau and Stonecutters Islands. Over Sham Shui Po and again over Kowloon City they turn to land on runway 13. To help pilots align themselves on the correct approach flight path, a location beacon giving green flashing signals has been erected on a hill near the Tai Hang Tung resettlement area. The beacon is about 4000ft from the beginning of the north-west approach lighting system. This system consists of a 3510ft line on an arc of a circle designed to conform to a rate-one turn* of an aircraft flying at 140 knots. The approach is then straight and in line with the runway centre line for the remaining 2800ft to the threshold bar. Lights are spaced 438ft apart on the curved section of the approach centre line and 200ft apart on the final 3000ft (from crossbar No. 3 to the threshold). Crossbars of lights installed at the start (No. 4) and finish (No. 3) of the curved approach and at 2000ft (No. 2) and 1000ft (No. 1) from the threshold help the pilot to judge the horizontal attitude of his aircraft and, since the final three bars decrease in width towards the runway, also give a rough indication of height.

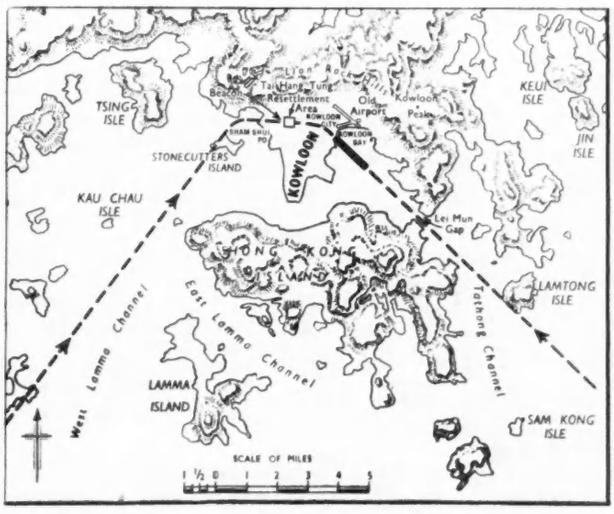


Fig. 1—Typical approach paths to the new runway of Kai Tak airport, Hong Kong

On the curved section of the approach, both the crossbars Nos. 2 and 3 and the high-intensity lights (which have a limited horizontal beam spread) have had to be duplicated and angled so that they present a complete lighting pattern to a pilot passing over the location beacon. Thus, on the initial approach, from the location beacon to crossbar No. 4, the pilot sees a complete lighting pattern from one set of lights, and then along the curve he sees it from the second set ; to assist in the transition from one set of lights to the other, with no intervening period of darkness, the beams have been arranged to overlap.

Since the end of runway 13 is so close to Kowloon City, the approach clearances are necessarily high and many of the approach lights have had to be mounted on the roofs of buildings or on specially erected structures. A typical structure is shown in Fig. 4.

Each of the high-intensity and low-intensity patterns is connected on individual duplicate series circuits fed from separate supply sources on the airport. The duplicate circuits are "interleaved" : each circuit feeds alternate lights, so that if one supply source should fail, the approach pattern is maintained, but with alternate lights only.

The runway is equipped with a dual system of high- and low-intensity lights spaced 200ft apart and each system is supplied by two separate series ring circuits, each fed from a different substation, so that, as with the approach lighting, failure of one circuit would cut out only alternate lights. These lights are of the elevated type (except at taxi-track intersections, where inset fittings have been installed), and are on frangible mountings so that little damage would be caused to an aircraft if it collided with them.

The runway lighting is white, except for the last 2000ft facing the approach where yellow filter screens have been fitted. This colouring gives the pilot an indication of range when taking off or landing : white for three-quarters of the runway and yellow for the remainder.

For landing, each end of the runway is marked by a threshold bar of green inset lights. Extending on either side of these bars are wing-bars of elevated high-intensity white lights, to give additional aid in bad visibility. Threshold and wing-bar lights are supplied and controlled from the airfield substations. Inset fittings have been used for the threshold bars because the high approach clearance over Kowloon City and the harbour has caused the bars to be located further down the runway than is usual and in stretches which may be used for take-off.

Each end of the runway is marked by a line of inset high-intensity red lights, but they are screened so that they can only be seen on take-off.

Running parallel with the runway for the whole of its length is a 75ft wide taxi-track with eight connecting tracks. All these

* A rate-one turn entails changing course at the rate of 3 deg. per second, e.g. an aircraft would complete a circle in two minutes.

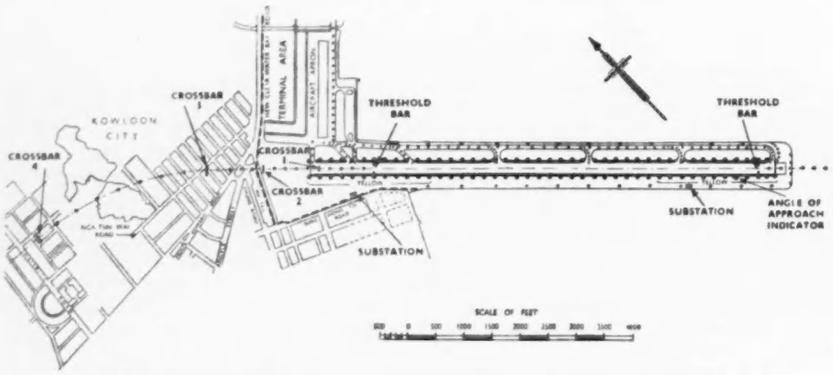


Fig. 2—Plan of approach and runway lighting at Kai Tak airport

taxi-track sections have been equipped with inset green taxi-way lights, spaced 160ft along the centre lines except at curves, where the spacing has been reduced to improve definition. These lights are supplied on separate series circuits, as with the runway lights, and there are twenty-four traxi-track circuits in all.

Aircraft approaching from the east enter the harbour through the Lei Mun Gap on a direct bearing with runway No. 31. The approach lighting for this runway consists of a 2000ft centre-line of high- and low-intensity lights spaced 200ft apart and mounted on piles in the sea bed. Both the high- and low-intensity systems are connected on individual series circuits fed through submarine cable from separate supplies.

In poor visibility pilots approaching to land on runway 31 are also assisted by two high-intensity angle-of-approach indicators, one on either side of the runway and about 1000ft down the runway from the threshold bar. These indicators give a flashing beam of light, divided horizontally into three coloured zones : if the pilot is too low, he sees a red light ; if he is too high, it will be amber ; green indicates that he is on the correct glide path.

Both the north-west and south-east approach systems are equipped with high-intensity lights to form lead-out patterns for take-off. The circuit arrangement for these lights is similar to that provided in the approach lighting. Since the low-intensity approach lights are omni-directional, they can be used as both approach and lead-out lights.

The outer edge of the promontory extending into Kowloon Bay is marked by red low-intensity elevated lights suitably spaced to give definite indication of the land limits, while the extreme end of the promontory is also marked with lights for warning shipping.

The whole apron is illuminated by floodlights mounted on 45ft high towers spaced along the north-west edge. These lights are designed to give wide horizontal and narrow vertical beam spreads, and can be adjusted to provide adequate coverage of the loading areas without dazzling pilots when taxi-ing.

All the high-intensity lighting in the approach, lead-out and runway systems, threshold bars and angle of approach indicators can be controlled separately in five steps of brightness, namely, 100, 30, 10, 3 and 1 per cent of maximum.

The main electrical supply to the airport is from the China Light and Power Company's network at 6·6kV, three-phase, 50 c/s, through transformers giving a 346V/200V, three-phase, four-wire supply controlled by a low-tension distribution switchboard which feeds the two main airfield lighting substations, one at each end of the runway ; the substation at the south-east end is below ground level. Each substation houses a low-tension switchboard containing the contactor panels required for the airfield lighting circuits. In each substation a diesel stand-by generator is arranged to start up automatically on either complete or partial failure of the incoming supply, and to shut down when the supply is restored.

All the airfield lighting, including the location beacon on the north-west approach, is remotely controlled from a console in the control tower. The console is equipped with switches for runway direction, lighting brightness control and circuit selection and has a mimic diagram of the whole installation. Miniature lamps in the mimic diagram represent circuits on the airport and the corresponding lamps light up when a particular circuit has been selected. There are visual and audible warning devices to indicate failure in any circuit.

As the substations containing the diesel stand-by generators and the switchgear controlling the incoming supply are normally unattended, the state of these equipments is monitored back to the control tower where a twenty-four-hour watch is kept.

The airport lighting design was finalised in its present form in liaison with Scott, Wilson, Kirkpatrick and Partners (the consulting engineers for the whole project), and Preece, Cardew and Rider, who prepared the detailed electrical design.

The contractor for the lighting system described here was The General Electric Company, Ltd., of England, and the installation was done by the associated company, The British General Electric Company, Ltd., of Hong Kong.

Fig. 3—The south-east approach lights to runway 31 are mounted on piles driven into the sea bed. Lei Mun Gap in the background

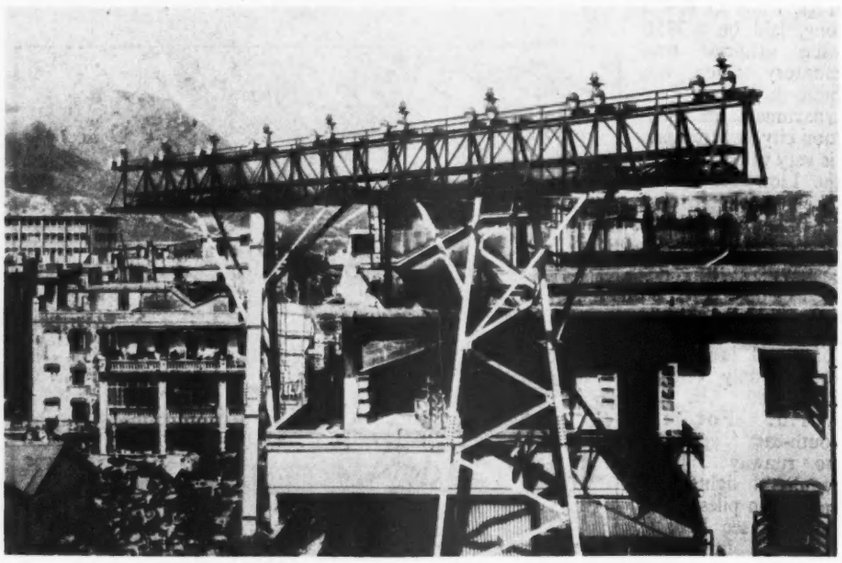
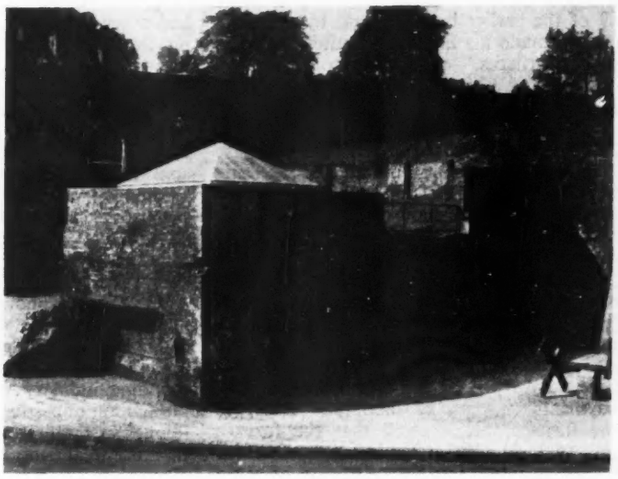


Fig. 4—High- and low-intensity lights on crossbar No. 3

Coke in Ironmaking

This week, the 250th anniversary of the successful use of coke for iron smelting has been celebrated by a series of meetings at Birmingham University. The technical and industrial importance of the achievement has been aptly surveyed by papers presented at these meetings. To-day, those attending the celebrations are visiting Coalbrookdale, where, in January, 1709, Abraham Darby I, first employed his coke process in ironmaking.



THE first successful application, early in 1709, of a process for using coke for iron smelting was an event which had a profound effect not only upon the whole future of iron and steel making but also, of course, upon this country's industrial development generally. It is fitting that the 250th anniversary of that event should be celebrated in the area in which such a significant technical achievement was first realised. The commemoration has been organised by a national committee, under the chairmanship of Sir Frederick Scopes, the membership of which included representatives of various technical and historical societies and industrial organisations.

The commemoration meeting began on Wednesday evening, at Birmingham University, with a lecture by Professor T. S. Ashton on "The Economic and Social Background of the Iron Industry in the Eighteenth Century." Yesterday, Thursday, four interesting papers were presented for discussion. The first of them, by Mr. B. L. C. Johnson, dealt with "The Midlands Iron Industry in the Early Eighteenth Century." In a survey of the background against which Abraham Darby's discovery was made, Mr. Johnson pointed out that the introduction into the iron industry of the coke smelting process at Coalbrookdale had little immediate effect upon the iron trade as a whole. Thirty to forty years after coke had come into regular use in Darby's blast-furnaces, there were only seventeen coke furnaces working in Britain and the greater part of the country's requirements for pig iron must still have come from charcoal furnaces. Mr. Johnson suggested that the reasons for the long delayed acceptance of coke pig as a basis for bar iron manufacture could not have been costs, but were as likely to have been prejudice and the vested interests of ironmasters in charcoal furnaces as much as sound consideration of the relative quality of the coke and charcoal products. The way in which partnership in the industry controlled all processes from furnaces to slitting mills could explain the strength of vested interest, but, Mr. Johnson commented, it was difficult to believe that, had Darby been in a position to flood the market with coke pig of acceptable quality and low price, he would not have been able to change the habits of forge masters. In all probability, the Darbys' concern with cast iron products in the early decades of the coke process and, possibly an absence of megalomania, meant that too little coke pig was available to compete seriously with charcoal iron.

The contributions of the Darby family to ironmaking and to the iron industry were succinctly dealt with in a paper by Dr. Arthur Raistrick. Dr. Raistrick is an acknowledged authority on the history of the Darbys and Coalbrookdale and, inevitably, much of the information included in his paper has a place in his *Dynasty of Iron Founders*. But in his paper Dr. Raistrick emphasised that members of the Darby family had taken many pioneering steps in the British iron and steel industry, from the first smelting of iron ores with coke in 1709 to the establishment of the modern industry on the new Midland iron fields, in the present century. Alongside this, Dr. Raistrick said, the Darbys made a significant contribution to the success of the Newcomen engine in their development of the cast iron cylinders. The Darby works became a centre to which, and in which, engineers were attracted or bred. Coalbrookdale turned out men who took part in the founding and development of other concerns such as Fawcett Preston of Liverpool, Carron Company, Perran Foundry, Neath Abbey iron works and the Bridgnorth Foundry.

In a paper entitled "Coalbrookdale, 1709," Dr. R. A. Mott detailed some of the outstanding events in the early years of the coke smelting process. Dr. Mott said that the chief problems of using coal (or coke) instead of charcoal as the fuel for making copper had been resolved in the decade before Abraham Darby I went to Bristol (in 1699), using a reverberatory furnace, one of the outstanding English contributions to metallurgical practice. There were two of these new works in Bristol but markets for their products were hard to find. Abraham Darby resolved this problem by founding, in 1702, the Bristol Brass Wire Company, in collaboration with Edward Lloyd, Benjamin Coole, John Andrews, merchants, and Arthur Thomas, pewterer, all Quakers, Abraham Darby being the "acting man." In smelting the copper ores, and in the refining of the copper, coke was used in at least some of the numerous stages and may have been made in one of the reverberatory furnaces in which the metallurgical processes were carried out. In making copper or brass, the sulphur content of the coal was of no metallurgical significance, but a low sulphur content would be appreciated by the brass melters, who had to extract crucible pots from above the coke. It seemed likely, Dr. Mott continued, that in this way Abraham Darby I appreciated the value of the low-sulphur coals of Coalbrookdale compared with those of Bristol, and considered that they might, as coke, be suitable for smelting iron ores, for the metallurgical disadvantage of sulphur in ironmaking processes was well understood. The success of the Bristol Brass Wire Company, Dr. Mott said, was shown by the fact that, whereas in 1697 only 160 tons of English copper were produced, in 1711 there were 250 tons used for making calamine brass and Bristol had become, and remained for at least a century, the greatest brass-making centre in England. Despite the success of this venture, Abraham Darby I separated from his partners in 1707, took out a patent for casting "iron bellied pots," formed the Bristol Ironworks, became a Freeman of Bristol and bound his apprentice, John Thomas, to him for three years, probably to keep secret the moulding process.

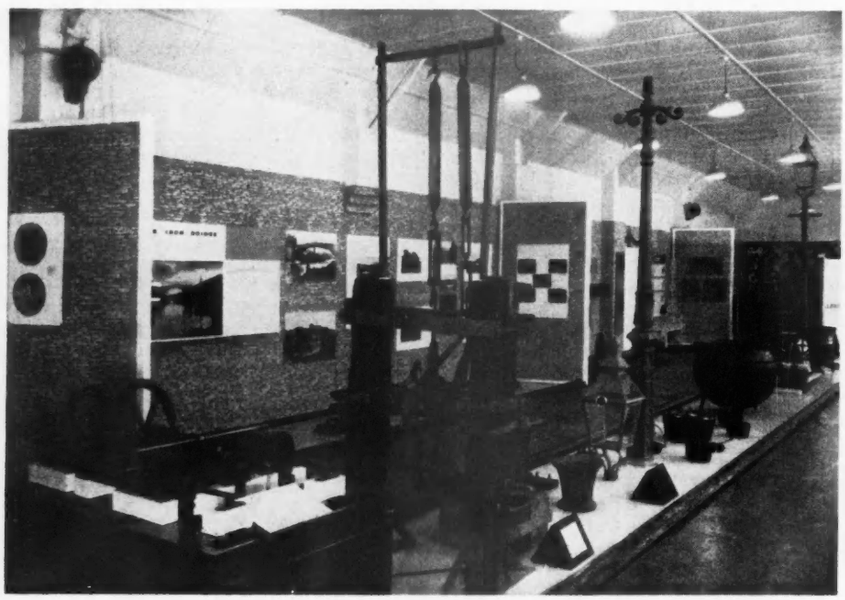
Dr. Mott went on to say that, from Michaelmas, 1708, Abraham Darby I rented, for £40 per annum, for the remaining nine years of the lease, the charcoal blast-furnace which had been built in 1638 by Sir Basil Brooke at Coalbrookdale. The Coalbrookdale accounts opened with a record of £104 14s. put in by Darby on October 20 and 23, 1708. The first payments were on October 23, for ironstone, and, ten days later, for breaking down the old hearth and for "landing" the new hearth stones. Thomas Milner, a Quaker iron merchant of Bewdley, advanced £15 for the purchase of bellows boards supplied by William Hall, possibly from Cranage or Vale Royal furnaces, Cheshire. By Christmas Eve, Darby had accumulated 244 dozens (512 tons) of ironstone, had repaired some of his buildings, and had received "big coal" sufficient for three heaps (each of 14 tons) for making coke by the hearth process, and sufficing to fill the furnace five or six times. He celebrated the warming of his furnace with meat and, it can be assumed from the details of subsequent celebrations, ale !

One week after this celebration, on Saturday, January 1, 1709 (N.S.), Abraham Darby I started his team of furnace men : Filler, Stocker, Keeper and Founder, and the two auxiliaries, mine-burner and coker. On January 25 he sent, to his Bristol ironworks, his first products, namely, 4½ tons of pig iron and a thick casting, so that the furnace must have been casting from about January 11, for the furnace drove at a rate of about 2·4 tons per week until April 3. On March 9 he sent 9 tons of pig iron (significantly at £6 10s. 6d. per ton instead of £6 as for the first batch) and the large amount of 5 tons of thick castings. On April 9 he sent a further 9 tons of pig iron to his Bristol ironworks, together with a few castings (now £10 per ton instead of the

£9 of the earlier batches), and by this date he had made his first thin castings, namely, four "furnaces," each of 65 to 85 gallons capacity, at £27 13s. 4d. per ton. After this run of twelve weeks, Dr. Mott continued, at an average rate of production of 2·4 tons per week, there was a disaster. The purchase of a tree from Benthall at £2 10s. (agreeing with dimensions 19ft long and 2ft diameter), suggests that the shaft of the water-wheel failed; but a new hearth was also laid and the costs (compared with those of later years) suggest that the common later practice of relaying 16 to 17 tons of hearth stones and 6 tons of bosh stones was applied and that the bosh had failed and destroyed the hearth and possibly the wheel shaft at the same time. By April 30 the resumption of shift payments (instead of labourers' rates) to the furnace men showed that the furnace was again in blast (after being out for four weeks) and there was another run of seven weeks at 2·3 tons per week, during which pig iron, thick castings (some at £14 per ton) and a variety of "potts, kettles, furnaces" were cast.

At this point Darby went to Bristol and there was a hiatus in the production; he probably went to effect a rearrangement of the works, which took effect in the second half of the year. In "ye first blast" he had proved the value of the enterprise which led him to the low-sulphur coals of Coalbrookdale, but he must have been agreeably surprised that his thin castings were superior to any he or anyone else could produce from charcoal-iron, for the higher silicon would make his iron more fluid and thus favour the essential requirement in making thin castings. Moreover, the manganese and phosphorus contents of Coalbrookdale iron, compared with Forest of Dean iron, which he presumably tried in establishing his patent, would tend in the same direction, so that the quality of his thin castings must have been surprising to him and all others who saw them. That the rate of production of his furnace was only one-sixth of that of a charcoal furnace was of small importance, for his coke cost him only about 10s. per ton, or one-sixth of the current price of charcoal in that area, and his casting process was not dominated by the requirements of a forge. In fact, he had established that his thin castings, of surprising quality, were saleable at a price higher than that of Swedish bar iron (£14 10s. to £16 per ton). His obvious aim was to develop his patent for making thin castings and he brought back with him, from Bristol, a new moulder, shortly afterwards to be augmented by another. The second blast started with the second half of the year, but for ten weeks his rate of production was only 0·9 ton per week, owing, no doubt, to deficiency of water supply, a feature which had usually caused charcoal furnaces to blow out for relining (and accumulation of charcoal) in the summer, and which was to remain a problem until, at first, a horse-gin pump, later a Newcomen engine, and, finally, the Watt steam engine, overcame it. This problem had resolved itself by the time Darby started his second moulder and from August 27 for a period of eighteen weeks to January 6, 1710 (N.S.), he produced an average of 1·9 tons of iron per week. His real achievement in this second blast was in developing his process of making thin castings: the production in relation to those of thick castings and pig iron was nearly 1 : 1 : 3, and his average return £12 8s. per ton. Clearly he had only to develop the production of thin castings, selling for at least £22 7s. per ton, to make his business extremely profitable. Thus, Dr. Mott pointed out, Abraham Darby I had succeeded, within a month of warming his furnace, in proving the effectiveness of the substitution of Coalbrookdale coke for charcoal and, within one year, of establishing his process of making thin castings. His problems were not therefore technical, but financial, for payment for his thin castings, sold through the fairs or markets of the Midlands, was slow and he had exhausted his capital in investing in twice as much ironstone as he had consumed in a year and in buildings, whilst debts owing to him at the end of the year amounted to £734.

The "commemoration symposium" was fittingly concluded with a paper by Dr. J. G. Pearce, entitled "Ironfounding—Past and Present." He explained that the ironfounding industry was concerned with the production of castings designed and intended for use in the cast state, irrespective of any thermal treatment, machining or finishing processes to which they might be submitted. The scope of the industry was thus independent of the raw materials, the moulding and processing techniques and the mould materials employed. It covered grey, white, chilled and malleable cast iron made in sand or other refractory material or in permanent moulds. Stemming from the iron industry and developing as a craft, Dr. Pearce added, using relatively simple iron-carbon alloys from locally occurring raw materials, expanding empirically using trial and error methods and the results of experience, ironfounding had emerged as a national industry employing some 130,000 people in about 1650 establishments, excluding those engaged on the manufacture and distribution of foundry raw materials, equipment and plant. It had an annual United Kingdom output approaching 4,000,000 tons of raw castings in a wide range of compositions, about one-tenth of the world output of iron castings.



Part of the Coalbrookdale Museum. Examples of the three-legged cooking pots, characteristic products of Abraham Darby I, are shown

The Coalbrookdale Site

Coincident with the commemoration of the first successful use of coke in ironmaking, The Coalbrookdale Company, Ltd., (now part of Allied Ironfounders, Ltd.), has completed the restoration of the original site and the "old furnace." The company has also established a museum, which is to be open to the public, and which effectively portrays its many developments over the past 250 years. We had an opportunity last week to visit Coalbrookdale to see the restoration work and the museum.

At the entrance to the site, there are some elegant commemorative gates which were designed and cast in the works earlier this year. The furnace area is a good deal below the level of the entrance, an indication of the extent to which the original works site has been overlain by building foundations and tipped material in the course of 250 years. On the site there are the remains of a water-wheel pit, a fountain made for the Great Exhibition of 1851, examples of early cast iron rails (made from 1767 onwards), and of a waggon of the kind used on them. There is also the chassis of a locomotive built by the company in the mid-nineteenth century.

On the west side of the old furnace, at ground level, there is a small area of foundation walls with much of the stone reddened by fire. These walls are part of the first furnace, built in 1638, in which Abraham Darby I used his coke process in 1709. This furnace was in use until 1777, when Abraham Darby III rebuilt it to a new design in preparation for casting the Iron Bridge. As can be gathered from our title illustration, the furnace is a square tower structure. Actually, this square structure is an outer casing to contain the furnace itself which is circular in section. The lining of dark slag-stained fire brick is surrounded by several courses of hard red brick and the whole is set within a strong square wall, the space between circle and square being packed with ganister and other fire resistant material. This double structure is surrounded by the outer case and all the spaces are tightly packed with selected rubble. This somewhat elaborate structure was undoubtedly necessary to cope with the stresses set up by the expansion and contraction of the furnace under great temperature changes. Returning to ground level, it is possible to see recesses on two sides of the furnace tower. The first one, facing towards the present works, probably contained an opening into the furnace to accommodate the tuyere. The

bellows would be placed at right angles to this wall with a water-wheel to drive them alongside the old foundation. The second recess is on the side of the furnace opposite the foundations and is the forehearth or tapping place from which the beams and varied members of the Iron Bridge were, no doubt, cast on a great moulding floor in front of it, but now somewhat beneath the present site level.

The furnace can be entered through the arch in the forehearth and its shape, a double cone, is clearly defined. Both the tuyere and forehearth recesses are spanned by cast iron beams, two having cast on them the following letters and date :

B E w 1638 E w B

The true meaning of the inscription, we were told, is not known, but these beams were part of the original furnace, re-used by Abraham Darby III when it was rebuilt in 1777. A careful examination has shown that the letter B is really a monogram of B and L, the B probably referring to Sir Basil Brooke who built the first furnace in 1638. The two upper beams of the four supporting the forehearth recess have cast on them in bold lettering the inscription :

ABRAHAM DARBY 1777

The museum is housed in one of the pattern shops near the site of this historic furnace. There are two rooms, a part of one of which is illustrated herewith. In the first of them, the exhibits are arranged to illustrate the many aspects of the long tradition of ironmaking in Coalbrookdale. There are examples of the Darby family's contributions to projects as diverse as bridge design, steam locomotion, firegrate production, and the versatility of cast iron as a material for practical decorative and structural purposes. The second, and smaller, room of the two emphasises the inspiration that artists have derived from industrial subjects ; it includes excellent reproductions of paintings by Wright of Derby, Loutherbourg and others.

Rock Cutting Suction Dredger "Port Sunlight"

The dredger "Port Sunlight" has been built by the Westminster Dredging Company, Ltd., and designed to cut soft and medium hard rock at depths up to 60ft with a maximum width of cut of 300ft. Pump capacity installed enables 4500 tons per hour to be delivered over a distance of 10,000ft.

SUCCESSFUL trials, in sandstone at the new Tranmere tanker stage, have been completed recently by the dredger "Port Sunlight," which was constructed at works of the Westminster Dredging Company, Ltd., at Bromborough Dock on the Mersey. The dredger has been designed to cut soft and medium hard rock in addition to operating in granular materials, materials such as coral and limestone, normally dredged after the use of a Lobnitz pattern breaker, can be dealt with economically and quickly. At the trials, which we attended at the invitation of the company, the "Port Sunlight" cut and dredged red ferrous cemented sandstone, having a compressive strength of 6400 lb per square inch dry and 5700 lb per square inch wet, a tensile strength of 104 lb per square inch and a density of 136 lb per cubic foot.

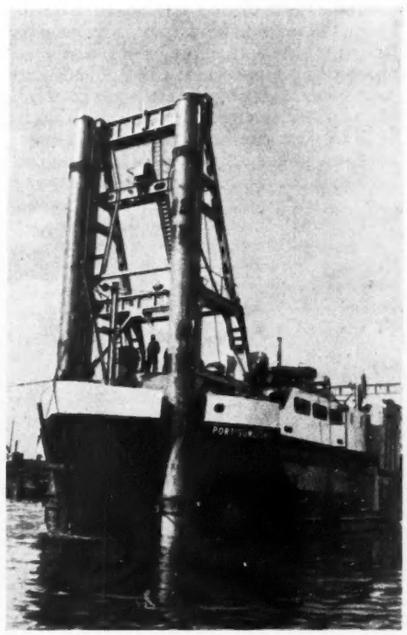
Our illustration, besides giving the general appearance of the dredger, clearly shows the cutting head and the ladder and also the spuds and associated mast and the stern. The following are the main particulars of the ship :—

Length between perpendiculars	166ft
Length overall	259ft 6in
Length overall, ladder unshipped	216ft
Breadth moulded	42ft
Breadth extreme	42ft 11in
Depth moulded	12ft
Draught normal	9ft
Dredging depth :	
Maximum	60ft
Minimum	10ft
Width of cut :	
Maximum	300ft
Minimum	100ft

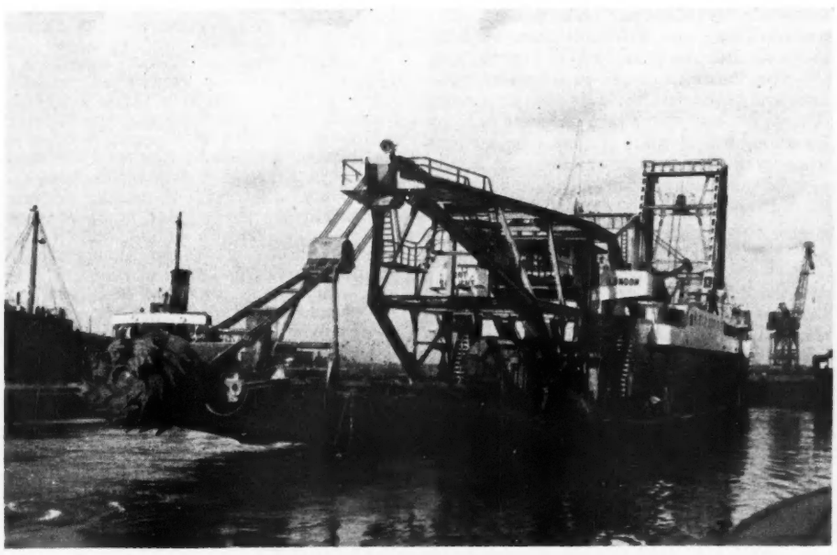
The hull, which is largely constructed of ½in plating, has been given a bow form structure at the stern to permit the dredger being towed stern first from site to site. In action, the "Port Sunlight" operates in a similar manner to other dredgers in that it rotates in an arc about one spud and uses both spuds to walk forward. The dredged material is disposed of ashore through a floating pipeline. The dredger is designed to work in depths up to 65ft of water and can remain in a tideway on its spuds, but when this depth limit is exceeded the dredge is kept in position in a tideway by a special stern mooring arrangement. Accommodation is provided for a total complement of twenty-one and the dredge is mechanically ventilated by fans supplied by Richard Crittall Marine, Ltd.

Measuring 8ft in diameter by 6ft in length, the cutter head has six blades, each fitted with seven hardened steel teeth, and weighs about 7 tons. The head is driven by a water-cooled, 1200 h.p. Allen electric motor, which is mounted on the after part of the ladder carrying the head and is splashproof and designed to operate at angles of tilt up to 50 deg. A double-reduction gear, having a 30 to 1 ratio, supplied by Power Plant Company, Ltd., transmits the drive to the cutter shaft, which has a diameter of 14in. The ladder, which weighs about 180 tons and is 90ft long, is raised and lowered at a maximum speed of 14ft per minute by means of a bridle and two sets of triple blocks, the power being supplied by the centre drum of three drums arranged in line athwartships. Port and starboard drums exert a pull on swing moorings placed to port and starboard and so swing the dredge in an arc about one spud. The maximum swinging speed is about 85ft per minute and the pull exerted is 35 tons. Power for the three drums is provided by a 200 h.p., forced-ventilated Allen electric motor, which drives through a Power Plant 15 to 1 double-reduction gearbox and finally through pinions and spur wheels and band clutches at each drum. In an emergency the ladder can be raised, at a reduced rate, by a 50 h.p. motor operating through the same transmission.

A second dredging winch is located aft and the drive is by a 150 h.p. Allen motor through a speed-reducing gearbox, pinions, spur wheels and band clutches to two drums which serve to raise and lower the two spuds. Maximum speed for raising the spuds is



Arrangement of spuds at the stern



Dredger showing cutter head, ladder and gantry

43ft per minute. A vertical drive through bevel gears from the gearbox output shaft drives the anchor hoist, arranged on the deck over, which consists of three drums driven through pinions and spur wheels and band clutches. The drums are used to transmit a pull on port, centre and starboard stern anchors when it is not desirable or possible to use the spuds. The latter, seen in our illustration, are located in spud keeps and are each 84ft long by 39in in diameter and weigh 34 tons, the wall thickness varying from 1¼in to 3in. The "A" frame spud mast can be lowered to allow the dredge to pass under points where waterline clearance is restricted.

Rock spoil can be delivered over a considerable distance at a high pipeline velocity by a 100in sand pump of special design, which has an enclosed impeller having four blades and which can operate at a head of 160 lb per square inch. About 4500 tons per hour is the rating of the pump, which absorbs 3500 h.p. at 375 r.p.m. delivered, through a Lohmann fluid coupling incorporating a Kingsbury thrust bearing, from a Mirrlees Mark KV SSA. 16 engine. This is a supercharged and intercooled 45 deg. vee-form unit having a bore and stroke of 15in by 18in. The centrifugal pump has 27in diameter suction and a 24in diameter delivery and an access hatch permits the removal of the complete pump for overhaul.

Dredgermaster's control console

In the machinery space arranged to port and aft of the engine powering the sand pump is a Mirrlees K SSA 6 diesel engine driving the 1000kW generator which provides power for the cutter motor. To starboard is a KA 6 diesel engine driving a 562kVA alternator, and a 175kW generator for powering the main winches and auxiliaries and a Thrige deck winch. Further aft and set athwartships is a Mark T.L.A. 6 diesel engine driving a 219kVA generator, while for providing power when the dredge is not working there is a 42kW G.E.C. alternator driven by a diesel engine. Auxiliary equipment includes Hamworthy service pumps and compressors, De Laval oil purifiers and Serck heat exchangers.

All the dredging operations are controlled from a house on the bridge, in which is installed a console, illustrated herewith, fitted with Westinghouse pneumatic controls. By means of these the dredgermaster has fingertip control over the speed of the cutter, the winches of the swing moorings, the raising and lowering of the ladder and also of the spuds.

Economics of Transport*

AN efficient and economical transport system is rather like Salvation. We are all in favour of it, but few of us are yet ready to accept the discipline and ideas which alone will ensure it. It has been well said that :

"It is thus on the law, on the response of the public to proposals for large schemes of expenditure to be undertaken on their behalf and on the attitude of legislators and administrators to current economic problems as much as (or more than) on technical improvement in the arts of carriage and on the structure of the industry that the future efficiency of British transport will depend." (Walker and Savage—"Structure of British Industry," *Road and Rail*.)

From this it follows, surely, that in fact it really depends on our own capacity to understand the issues and to order our affairs sensibly.

Briefly, we must begin by realising that the true economics of the Road-Rail Question lie beneath the surface and are complicated enough to justify a real humility in any approach to them. We must, also, get rid of some of the old doctrines no longer suited to present-day conditions. Neither Back-to-Nature† nor Forward - with - Big - Brother‡ is a solution. Nor is it any longer necessary to encourage civil war between the public carriers, especially the passenger carriers. Quick, easy, and total solutions of the Road-Rail Question do not exist. We cannot escape the pressing need to study the *social costs* of each "animal" in its proper environment and employment, and to find ways of employing them all in due combination. For this we must look at Carrying separately from Track.

The present social urge is away from the cheapest pattern of transport, and towards the private car and the "C" licence. No doubt the benefits of such transport are only too obvious to the individual, but we must also calculate the *social benefits* of preserving a proper measure of public transport, road and rail ; its advantages are enormous, though we can assess these benefits only by imagining the situation if there were no such transport. Apart from the fantastic inconvenience of such a situation, there are many areas in this small and crowded island where traffic would not get through, physically, unless carried collectively (train or bus).

As remarked, the more we move around, and the faster, the more room we need ; or the more discipline, or both. Many people think that the occasions and areas of congestion will increase further, i.e. the increase in private cars will be ahead of any increase in road facilities which the country can finance. Still, new facilities must be provided. But the better roads will be used free of extra cost by the road carrier, whereas the cost of improved rail facilities falls directly on the railway carrier. This cannot be justified by arguing that the road carrier is already paying too much in any case, and more than the rail carrier ; on like-for-like calculations road is paying *less* for its track than rail. What should be the proper relative charge for track to road and to rail is another matter. Likewise, the criteria which should govern the provision of new track, chiefly road track, of course, are not easy to determine. At least we should see that like tests are applied ; also, a broad and long-term view is normally essential, and the deeper we delve the more we may find that track problems (road and rail) should be regarded as indivisible.

A new approach to the Road-Rail Question is required, and somehow a co-ordinated one ; in particular the problems of Track seem to call for joint study and research, road and rail, and a community of policy as regards both provision of track and charging the carriers for it ; but engineers and economists have a considerable contribution to make to the further study of road-rail economics generally.

Evaluation of the social economics of transport is not something in which mathematical or definitive answers can be expected over the whole field. But we can distinguish our varying degrees of knowledge, and learn to know what we don't know. And by defining, analysing and measuring the factors as far as we can we shall probably save ourselves great sums of money and untold frustration. Whereas ultimate policy on the Road-Rail Question is more a matter of art than science, there will be no wise policy which is not based on a scientific approach to the facts.

* From a British Association paper by Sir Reginald Wilson.

† Broadly, "free-for-all" competition without any regulation or co-ordination.

‡ Broadly, complete regulation, as within transport nationalisation covering all transport.

Fire Research

THE reports of the Fire Research Board and the Director of Fire Research for 1958 have now been published by the Department of Scientific and Industrial Research and the Fire Offices' Committee under the title *Fire Research*, 1958. A study of fires on domestic premises showed that the incidence of fire is seven times as great when electricity is used as an energy source than for coal or coke, for equal amounts of heat released, even when the electricity used for lighting, entertainment, refrigeration, power tools, and so forth is included. Since the domestic consumption of electricity is increasing (at present it is about one-tenth the amount of solid fuel) the total incidence of fires in the home must be expected to increase. Another hazard to which particular attention is drawn is the high flammability of clothing in an atmosphere with an increased partial pressure of oxygen.

A certain amount of full-scale experiment is reported, including the burning of cordite in stacks of up to 40,000 lb. The Joint Fire Research Organisation and the Fire Research Section of the Building Research Division of the National Research Council of Canada burnt eight buildings in Aultsville, a town that was inundated as part of the St. Lawrence Seaway project ; the results of these experiments may provide valuable information on the separation necessary between buildings. Tests on mock aircraft fires were extended to larger fires ; photographs show the conflagration of 900 square feet of petrol being extinguished by a single foam tender the 85 h.p. Fordson with a 300 gallon tank, using but one monitor. Foam also has been used experimentally to extinguish petrol burning in storage tanks, the foam being injected into the base and floating to the top, I.C.I., Ltd., having made available a tank 50ft in diameter for tests. Another technique of extinction, at present being tested on models, is the substitution of an inert atmosphere in a building ; it is proposed to derive this from a turbojet with after burning—by quenching the exhaust with water, the combustion and dilution together reducing the percentage of oxygen to about 8.

Mainly Metallurgy

by T. Henry Turner, M.I.Mech.E. M.I.Loco.E. A.R.Ae.S. F.I.M.

Twenty Years of Corrosion Research

The Sixth Report of the corrosion committee recently issued records a really outstanding part of the attack on the two problems of the nature and of the prevention of the corrosion of iron and steel, which is at long last made public by the Iron and Steel Institute's Special Report No. 66. In the 217 octavo pages of this little book no less than twenty years of carefully planned and often very costly research are reported. Dr. W. H. Hatfield, F.R.S., was the main source of inspiration of the Corrosion Committee, which the Iron and Steel Institute set up in 1928.

The first five reports of the corrosion committee were published in a series of maroon coloured booklets, which contained much technical detail. As the scope of the work expanded, and the guidance of the numerous researches came under sub-committees of specialists, this method of reporting gradually became less convenient. The decision as to whether such all-embracing reports had become inappropriate was never taken because the 1939–45 war intervened. During that period leisurely and really scientific reporting became impossible and any usable results of the committee's researches were made available to those most directly concerned, as soon as they became available. Hence for twenty years there has been no all-embracing review of the work of the corrosion committee and of its numerous sub-committees, available to the general public and libraries.

At the end of the year 1946 the Iron and Steel Institute's corrosion committee was taken over by the newly-formed British Iron and Steel Research Association, losing some of its former amateur status but gaining in professional strength. Many aspects of its work had been made public by the appearance of many scientific papers, but it became obvious that there was a need for this further review of the whole of the work to be available for scientists in general and especially for those who may in the future take part in this very essential work.

Such a review was by no means easy to produce, but very fortunately the senior investigator to the committee, Dr. J. C. Hudson, has been in direct and continuous contact with these researches for thirty years. He it is, therefore, who has now, on behalf of the committee, compiled this "Sixth Report." Strangely enough the report, which is in the form of an octavo book, does not contain the address of the Iron and Steel Institute or of the B.I.S.R.A.; this was an oversight and copies may now be purchased from The Iron and Steel Institute, 4, Grosvenor Gardens, S.W.1.

The following seven fields of corrosion research have been worked over by the numerous sub-committees :

1. Atmospheric corrosion tests on a wide variety of wrought irons, cast irons, mild steels and low-alloy steels, have been carried out by the committee all over the world for periods up to fifteen years.

2. Corrosion by Industrial Waters was reviewed in a separate brochure produced by the sub-committee in 1949. Since then corrosion by cold potable waters and inhibition by sodium silicate have been studied.

3. Marine corrosion was of necessity studied almost feverishly in the early days of the war and valuable work was done on ship's bottom paint compositions. Since then more leisurely work of a really scientific character has continued on the corrosion of bare iron and steel and the effects of surface preparations in immersed conditions.

4. Soil corrosion of costly pipelines has been studied by means of many field tests of bare and coated iron and steel pipes.

5. The many claims for all sorts of surface coatings for iron and steel were, and indeed still are, confusing to the designers of structures. To give guidance without trade or process bias was therefore set as the aim of the Protective Coatings Sub-Committee. All types of coating, priming and finishing paints, metallic plating, dipping or spraying, and heat resisting coatings—all these have been studied impartially.

6. Great difficulty has been experienced in trying to find short time laboratory tests, and long time exposure station tests, which give acceptable correlation with the corrosion experienced in service. A separate sub-committee has therefore been constantly at work on the corrosion testing procedures, and useful advice is available on phosphate coatings and on the B.I.S.R.A. rotor apparatus for corrosion testing.

7. Finally the committee enjoyed the help of its present chairman, Dr. U. R. Evans, F.R.S., while he worked in Cambridge University on the fundamental scientific side of corrosion research. In return some part of the work done by his many research student collaborators was assisted by the committee.

There is much in all this work that will prove of value to the users of iron and steel, but space will only permit of reference to one example here, which will be of value to almost all kinds of engineers. This underlines the paramount importance of the preparation of the steel surface before it receives its first coat of paint. The committee found that, when using two coats of red lead in linseed oil paint followed by two coats of red oxide in linseed oil paint, under fully controlled conditions the average life in years, at three different test sites was as tabulated.

Hence the life of this excellent four-coat system of painting steel varied from three to ten years depending upon the nature of the preparation given to the steel surface before applying the first coat.

Place	Test Site	As rolled	Weathered	Descaled
Calshot	By the sea	9·1	6·9	15·8
Llanwrtyd Wells	High on a Welsh mountain	5·3	2·1	6·4
Sheffield	Surrounded by industries	8·1	3·0	10·6

Powder Metallurgy

The expansion in the manufacture of metal powders and the increasing diversity of engineering components produced from them deserves attention. In 1947 the Iron and Steel Institute held a symposium and note was taken of very considerable developments in equipment and techniques. As a consequence a committee was set up in 1953, representing both the Iron and Steel Institute and the Institute of Metals, and papers were invited from home and abroad with particular emphasis on research and development. These papers were presented at a two-day symposium held in London in 1954, and they were published in a special report covering 390 pages. This was divided into four sections :

1. Manufacture, properties, and testing of powders.
2. Principles and control of compacting and sintering.
3. Manufacture and properties of structural engineering components.
4. Powder metallurgy of high-melting-point alloys.

Three years later these two metallurgical Institutes collaborated, in a very praiseworthy manner, in forming the "Powder Metallurgy Joint Group of the Iron and Steel Institute and the Institute of Metals" to study the science, technology, and practice of powder metallurgy.

Membership of the group is restricted to those who are members of either of the two Institutes, and it was planned that the group should normally meet formally twice each year. The Spring meeting was to be devoted to industrial aspects and the Autumn meeting to original research in some field of powder metallurgy. The octavo-sized official publication of this Powder Metallurgy Joint Group is entitled "Powder Metallurgy" and Parts 1 and 2 were issued as one volume in 1958 so that all papers so far contributed to the group were recorded in printed form.

Now in 1959 Part No. 3 has been published in a similar form. These first two volumes of "Powder Metallurgy" record the inaugural lecture and symposium of seven papers on "Development in the production and quality of metal powders," in December, 1957. The second meeting heard and discussed seven papers on "Developments in the practice of compacting and sintering," in March, 1958. The third meeting was a symposium of six papers on "The powder metallurgy of metal-ceramic materials," in December, 1958. The fourth meeting heard and discussed seven papers on "Theoretical aspects of sintering," in April, 1959.

The second volume also contains five more papers on compaction and related matters. In this way the group has already printed no less than thirty-two papers, which make available, in an accessible manner, an increasingly valuable contribution to our knowledge of this rapidly developing subject.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

ISAMBARD KINGDOM BRUNEL

SIR,—In his reappraisal of Isambard Kingdom Brunel, Mr. Newhouse does well to strip his subject of spurious honours, but is unjust in relating Brunel to a twentieth century background. That Brunel was a character out of balance must be admitted by his most fervent admirers, but his great courage, excessive energy, and personal magnetism which are apparent even after a century did much to redress his deficiencies in administration and design. That he could be brutal is admitted . . . during the Crimean War an interview between I. K. B. and a military gentleman is said to have so shocked the latter that he was never quite the same afterwards. How laudable and how sad that thousands of others connected with that inglorious war were not treated in a similar manner.

When Mr. Newhouse makes deductions from facts one can follow his reasoning, but his mention and acceptance of Scott Russell's opinion shows that a full examination of sources has not been made. Far from putting a foot wrong by engaging in gun running, which would not have been unprofessional, Scott Russell defrauded a firm of armament makers and the U.S. Government so that the former made some heavy guns for which they were not paid, and the latter paid for arms which they never saw, the recipient of all moneys being Scott Russell. A full account of these transactions was published for corporate members only immediately after the inquiry which led to Scott Russell's eclipse in I.C.E. affairs. No copy of this book is now available at the I.C.E., but at least one copy is extant and this I have studied. On the basis of such study I would not accept a word that Scott Russell wrote or uttered, nor can I advance any opinion as to how the matter was kept within the Institution as had it become public nothing would have saved Scott Russell from conviction and a long term of imprisonment. One would certainly not glean anything of Scott Russell's eccentricities from the lengthy and flowery obituary which appears in the *Transactions* of I.C.E.

It is difficult to accept the opinion that the only assistants who would work for Brunel had no chance of other employment. Telford has been named in the reappraisal and it is interesting to note that Telford could be as harsh as Brunel and that for this purpose he sometimes employed an intermediary who was known as "Telford's Tartar." There must be something truly impressive about Brunel and one cannot dismiss as credulous or simple minded the entire multitude of Victorian capitalists who backed him through success and failure.

Shorn of all gimmicks and presented with all his faults, Brunel's success amounted to more than his losses, and he never shirked personal, financial or moral responsibilities. In an era when empiricism was still very much the accepted order, he produced results which were often magnificent. A peculiar analogy may be drawn between Brunel and the Duke of Wellington, the former made headway even though he was probably but little indebted to design, whilst the latter was able to win a war employing field and general officers whose notions and training were a century out of date. It is probable that Brunel's great misfortune was to be born out of his century. Had efficient pumping engines and modern plastics been available, his ill-fated atmospheric railway would doubtless have been a great success. Before closing, it is desirable to clear up a few points concerning the disastrous "Great Eastern" steamship. In his essay, Mr. Newhouse appears to entertain the opinion that Brunel was unaware or careless of the effect of a large mass of iron upon compasses. A perusal of the most recent work, (*The Great Iron Ship*) will reveal that not only was great care taken in providing the best navigational aids available but that master mariners of outstanding attainments were invariably selected to command a vessel.

If Mr. Newhouse has taken Brunel from his pedestal no one can complain, as a man of such stature needs no artificial aids. Brunel was truly fortunate inasmuch as early errors were overlooked and he was of such personality that he could survive disasters without shelving responsibilities. Mention has been made of a great conflict of evidence. To a large extent, surely this is accounted for by the fact that throughout his life Brunel was news of a controversial nature. Some people detested him and others believed he could do no wrong, and very few were able to take an unbiased view of him. It would, therefore, be very strange if there were consistent agreement. Lastly, it may even yet be too early to rank Brunel in his profession and even if it were not, what object can there be in making the attempt. By the time that all great civil engineers can be arranged in due order, their names will have become unknown, as have those of the men who slaved and built the Pyramids.

G. F. R. DICKINSON

"Greentiles,"
Greencliffe Avenue,
Baildon,
September 15, 1959.

SIR,—One wonders how much reliance one can place on Frederic Newhouse's own "attention to detail" in his article "Isambard Kingdom Brunel—A Reappraisal" when he describes the Clifton Suspension Bridge as being "near Bath": so it is but somewhat nearer Bristol I think.

The completed bridge whilst not perhaps exactly to the original design is very much nearer it than Telford's, whose design was a hideous piece of Victoriana nearly filling the whole Avon Gorge.

Mr. Newhouse's preference for narrow gauge railways reveals one of the dangers of standardisation currently being demonstrated by Nato where one standardises not on what is best (undoubtedly broad gauge), but on what you have the most of. When broad gauge was finally defeated by the narrow-minded narrow gaugers Brunel made his G.W.R. run with both sets of rails and then changed over to narrow gauge in a single night. Needless to say this fact is not mentioned.

The atmospheric railway was in advance of the materials available but before the rats ate the tallow off the leather it propelled trains at over 50 m.p.h.

Turning to ships, the "Great Western" was considered most successful and the various mishaps detailed were common to all vessels of the period when steam navigation was in its infancy. It is stated that the "Great Western" was broken up after less than twenty years' continuous service and the G.E. [Great Eastern] after less than thirty, as if the ships were scrapped in their first bloom of youth. To-day, twenty years is considered the useful life of a ship, and in those days considerably less could be considered reasonable.

The G.E. as the name implies was built for the Far East trade, but was never so used by its owners. This probably accounts for its failure, as much as Brunel's "lack of attention to detail." It was, after all, the largest ship in the world for nearly forty years. In these days of specialisation I can't help but admire the breadth and sweep of Brunel's imagination and his pride in getting so many of his projects completed. No doubt he made many mistakes, but if he "lacked the essential qualities for an engineer," how many of us now can claim that title ?

J. A. YOUNG,
A.M.I.C.E., A.M.I.Struct.E.,
A.M.I.Mun.E., A.M.I.W.E.

45, Harcourt Road,
Bristol, 6,
September 18, 1959.

SPIRALLY WELDED TUBULAR PILES

SIR,—The articles included in the August 21 edition of THE ENGINEER regarding a spirally welded tube for piles and a spiral tube welding machine, prompt me to point out difficulties that can be experienced with this material if adequate inspection and testing arrangements of the welded steel tubes are not carried out. The writer has been concerned with the inspection of a large number of such tubes to be used as bridge piling which were driven internally with a drop hammer striking a plug of concrete in the base of the tube. It will be evident that at some stage during driving every inch of the welding will be stressed and should there be any particular point where during manufacture the continuity of the weld has been interrupted for a short distance, complete failure of the tube can result.

Normally, continuously welded steel tubes which are to be used for gas and water are all hydraulically tested to prove watertightness and also the continuity of the weld. At this stage should weld defects occur, they are quite easily detected and

satisfactorily remedied by cutting out and re-welding by hand over the faulty portion.

It is not made clear in the articles whether equipment is available for testing the finished piles, but it cannot be too strongly emphasised that all steel tubes to be used for piling should have some physical test applied in order to prove the continuity of the weld. It is suggested that the simplest test would be the normal hydraulic pipe test with pressure applied so as to stress the tube to at least 80 per cent of the guaranteed minimum yield of the raw material. For simple practical purposes, the pressure could be worked out from the usual formula for calculating the stress on thin cylinders.

It is possible that driving from the top reduces the stress across the weld, but at the same time, the extent of welding faults with the Submerged Arc Process can be quite extensive in certain circumstances, and unless a proof test on the complete length of weld is applied, even this method of driving may lead to failure.

D. N. JONES

2, Little Smith Street,
Westminster,
London, S.W.1,
September 17, 1959.

ARMOURED CAR DEVELOPMENT

SIR,—With reference to the article "Sixty Years of Armoured Car Development," by R. M. Ogorkiewicz, which appears in Volume 208, No. 5404, of THE ENGINEER, the statement that the prototypes of the Alvis "Saladin" were built in 1953 by Crossley Motors, Ltd., is not strictly accurate.

The prototypes were made by Alvis, Ltd., and as there was some question of our manufacturing capacity at that time, six preproduction vehicles were made by Crossley Motors, Ltd. By the time they were built the Alvis capacity was sufficiently increased to cope with all versions of the FV.600 series.

W. M. DUNN,
Chief Engineer, Vehicle Division,
Alvis, Ltd.

Coventry,
September 18, 1959.

Book Reviews

Materials for Rockets and Missiles. By R. G. FRANK and W. F. ZIMMERMAN. Macmillan Company, New York, 10, South Audley Street, London, W.1. Price 31s. 6d.

THERE is no doubt that the new field of missile engineering is no longer a mere extension of aeronautical engineering and it is recognised that many of its problems must be treated in their own context. Amongst these there is none more vital than that of material selection. The conventional data that have been available to the designer in the past have become more and more inadequate as the demand for greater strength with lighter weight or higher temperature has increased, especially when the operating times are reduced to periods of minutes. This has led to much research and development over the past dozen years on materials to withstand the increasingly severe internal conditions of turbine engines, reheat and ramjet combustors, and rocket chambers and nozzles. In addition, however, the missile external conditions have become more severe as, for example, in the hypersonic re-entry of ballistic or satellite vehicles. Still more problems will arise with the advent of nuclear-powered craft and any information on irradiation and shielding properties of materials is of importance. All these subjects have been considered in this present book in a concise and handy form. There are eleven chapters and the data in them can be listed broadly under the headings of (1) high temperature sheet, wrought, and cast alloys of iron, nickel and cobalt; (2) aluminium and magnesium alloys; (3) titanium alloys; (4) cermets; (5) refractory materials, e.g. molybdenum alloys; (6) ceramics.

The authors do not claim to deal exhaustively with all known materials in these categories, but rather they select information on outstanding materials so that the reader can appreciate the limitations and possible applications. They begin with tables giving the chemical make-up of the compounds and some of their more important physical properties. Other tables give comparative assessments of such features as oxidation resistance, weldability and maximum service temperature. Brief, but simple, explanations, easily understood by non-experts, are given of many of the material features, and these add much to the value of the book. These are supplemented by microphotographs and the whole enables the reader to appreciate the subject very thoroughly. Apart from this, the most important feature of the book is the large number of diagrams on which stress, temperature and elongation curves are plotted not only for ultimate strength but for rupture at both ten hours and 100 hours and for fatigue failure after 10^8 cycles.

The penultimate chapter departs from the study of physical data to give a useful discussion on developments in fabrication methods. These include high temperature brazing, welding of thin sheet metal and forming methods. The latter is referred to as "chipless" production and includes conventional spinning processes, drawroll forming, die rolling and "slick mill" rolling.

The final chapter has a good concluding discussion on the materials presented in the book and summarises their main properties in four diagrams. Altogether it can be said that this slim volume contains more information of value to designers and engineers than many books of several times its size. It is recommended without reservation.

Transistor Electronics. By A. W. LO, R. O. ENDRES, J. ZAWELS, F. D. WALDHAUER, C. C. CHENG. Macmillan and Co., Ltd., St. Martin's Street, London, W.C.2. Price 45s.

THIS book contains a large amount of useful material but it suffers from what must be regarded as a serious disadvantage with such a subject in that all the evidence suggests that the bulk of the material was not written after 1954. Much of the fundamental information is not affected by the date at which it was written, but certain modern developments are omitted and fairly detailed circuit data are provided on obsolete devices which give a wrong emphasis and detract from the value of the book as a whole.

After a preliminary chapter on fundamental transistor physics there is a thorough treatment of characteristics, parameters and equivalent circuits. The basic amplifier configurations are then considered and the question of noise is dealt with in some detail. The matter of d.c. bias is well covered except that the criterion for thermal runaway is not mentioned. In the chapters that follow on l.f. and power amplifiers a good practical treatment is given. However, methods of overcoming the serious fall-off of current gain with high emitter currents are not even mentioned although they have been in common use for some years. There are three chapters on h.f. operation. The first on the mechanism of operation, the next on the derivation of the parameters and the third on h.f. amplifiers. A mere four and a half lines is given to the surface barrier transistor and half a page to *pnip* and *npin* types. More recent types are not considered. The final chapters deal with oscillators, modulators and demodulators and pulse circuits. In the case of oscillators and pulse circuits the emphasis is very firmly on point-contact transistors.

In the majority of the literature nowadays, the symbol originally devised for the point-contact transistor is used for the junction type. In this book, however, a different symbol is used which, though perhaps more logical, gives a strange appearance to circuit diagrams. It would seem a pity to break away from what has become standard practice (and has indeed been covered by a British Standard) particularly since the distinction between the two types is largely a matter of academic interest in view of the eclipse of the point-contact type.

The inclusion of new material and the omission of that which is dated would add to the value of this book because in its present form it cannot be recommended without certain reservations.

Books Received

The Atlantic Cable. By B. Dibner. Burndy Library, Norwork, Connecticut, U.S.A. Price 2.50 dollars.

Ground Water Hydrology. By D. K. Todd. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 86s.

Plane Trigonometry. By A. W. Goodman. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 36s.

Merchant Ships: World Built, Vol. VII. Adlard Coles, Ltd., 7, Brunswick Place, Southampton. Price 35s.

British High-Speed Diesels. By C. Morgan-Jones. Temple Press, Ltd., Bowling Green Lane, London, E.C.1. Price 15s.

Analysis of Straight-Line Data. By F. S. Acton. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 72s.

Package Design Engineering. By K. Brown. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 68s.

Trockner und Trocknungsverfahren, Vol. 2. By K. Kroll. Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3, German Federal Republic. Price DM.69.

Notes on Pipework Design. By A. A. Smith. Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey. Price 3s. 6d.

The Geometry of Conical Pipes, Bends and Joints By W. Sellar. Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey. Price 3s. 6d.

Experimentelle Untersuchungen an Geraden und Gekrummten Diffusoren. By H. Sprenger. Verlag Leemann A.G., Arbenzstrasse 20, Postfach, Zurich, 34, Switzerland. Price Sw.Fr.17.

Statistical and Other Data on Minerals—October to December, 1958. The Overseas Representative, Department of Mines, South Africa House, Trafalgar Square, London, W.C.2. Price 5s.

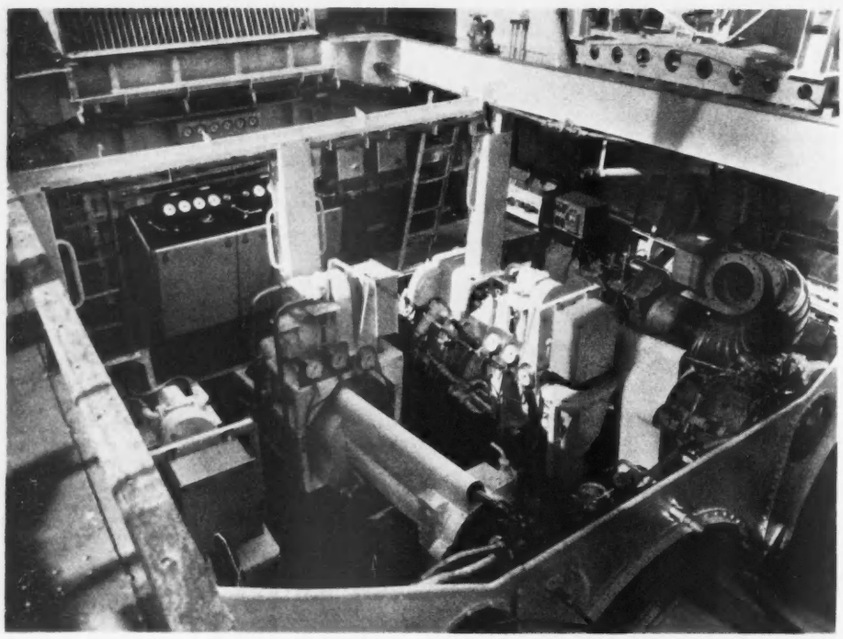
Sampling Inspection Tables—Single and Double Sampling. Second edition. By H. F. Dodge and H. G. Romig. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 64s.

An Introduction to Product Design and Tooling. By S. C. David. Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey. Price 3s. 6d.

Lubrication of Bearings: Theoretical Principles and Design. By E. I. Radzimovsky. The Ronald Press Company, 15, East Twenty-Sixth Street, New York, 10, N.Y., U.S.A. Price 10.00 dollars.

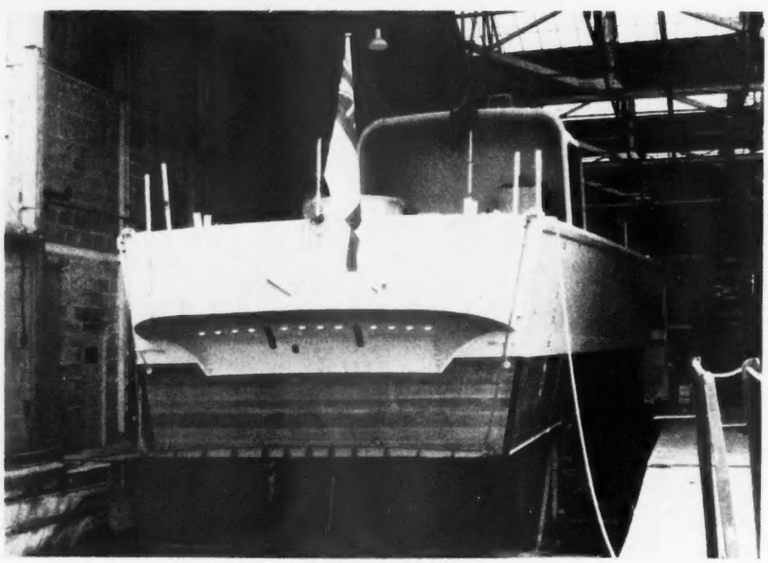
Gas-Turbine Warship

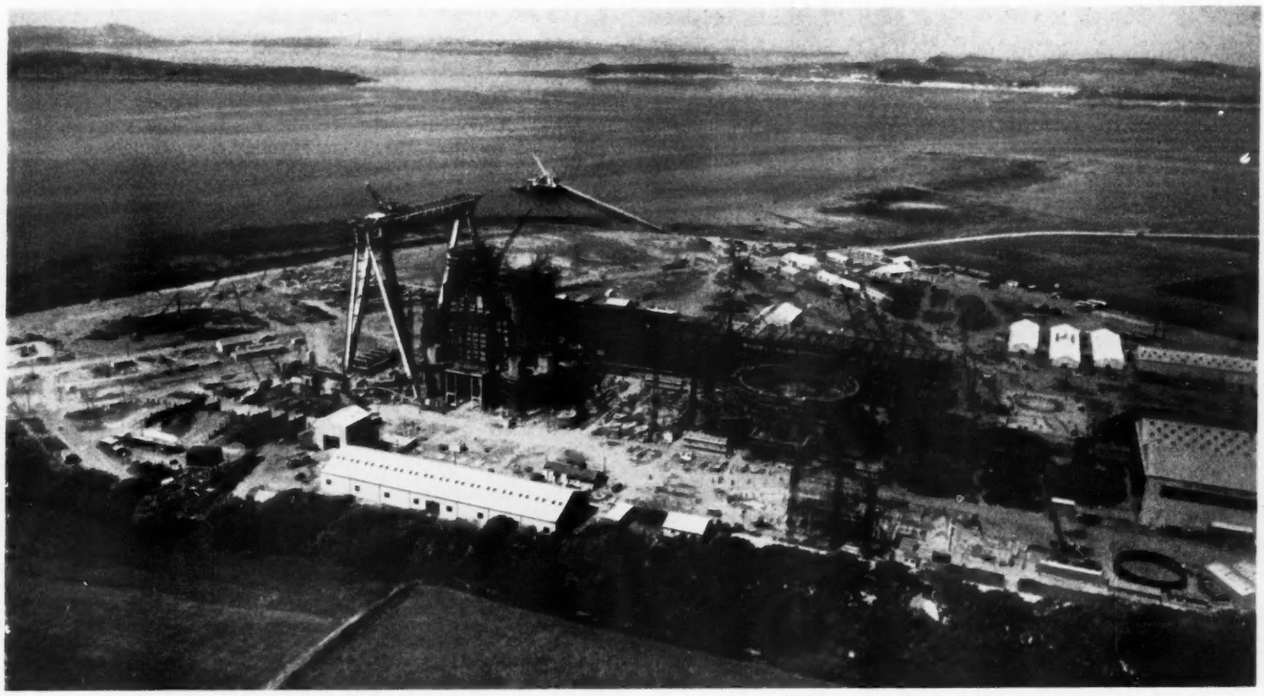
Now completing its trials from the Portsmouth yard of Vosper, Ltd., is the first of two fast patrol boats for the Royal Navy, H.M.S. "Brave Borderer." Having exceeded 50 knots on trial, she is regarded as the fastest fighting craft in any service. In action, the armament would be reduced from the complement seen RIGHT by omitting either one of the 40mm Bofors guns or two of the 21in torpedoes.



The new craft is powered entirely with gas turbines, the main propelling plant comprising three Bristol-Siddeley "Marine Proteus" Mark 1270, an uprated version giving 4250 s.h.p. at a turbine temperature of 852 deg. Cent.: the specific consumption at full power—output speed 11,400 r.p.m.—is 0·575 lb s.h.p. hour. In the "Brave Borderer" the exhaust ducting is of austenitic steel and its endurance limits full power to thirty-minute periods: continuous maximum of 10,000 r.p.m. corresponds to 45 knots. The use of gas turbine machinery offers exceedingly rapid start-up from cold, and the power for starting and ship's services is provided by two Rover IS 60 generators giving 40kW at 3000 r.p.m.: hand cranking these occupies the bulk of the time needed to reach full power. The main engines and gearboxes are controlled, by one lever each, from the bridge, and when operating the engine-room is unmanned, the engine-room instruments being concentrated on "Plasteck" panels in the Action Information Office. On the LEFT is seen the machinery space, with, in the extreme foreground, the shields round the combustion chambers in the aft engine-room: in the forward engine-room can be seen the high-speed drives to the Allen V-drive reversing gearboxes and one of the two auxiliary engines, the exhaust ducts of which form the prominent bipod on deck aft.

The ship is built principally of welded aluminium alloy members, diagonally planked with mahogany and sheathed in glass fibre. In the picture RIGHT there can just be discerned the three rudders. Across the transom is fitted a flap to trim the craft when planing, adjustment of this being remote from the bridge. The diameter, and drag, of the shafts have been minimised by eliminating keys from the propeller bosses and assembling an interference fit by the Timken hydraulic pressure expansion technique. There can be seen the large shelf which protects the exhaust outlets from water entry, and for additional safety any engine not in use can be blanked off by a hinged cover. We are advised that the ship can be fought in Force 5 winds compared to Force 4 for last-war craft, so that the days in which English coastal weather is too severe have dropped roughly from one in three to one in six. The average displacement is 95–100 tons, and the length is 96ft.





Site Welding at Hunterston

The aerial view we reproduce above shows the present state of progress at the Hunterston nuclear power station which is being constructed by The General Electric Company, Ltd., in collaboration with Simon-Carves, Ltd., for the South of Scotland Electricity Board. This article on the site welding of vessels for this project, is based upon notes which were received from the Consolidated Pneumatic Tool Company, Ltd. Full details of the Hunterston project were given in our issue of February 8, 1957, *and a progress report in the issue of July* 11, 1958, *included a description of the 300-ton Goliath crane used on the site.*

STEADY progress is being made at the nuclear power station being built for the South of Scotland Electricity Board at Hunterston by The General Electric Company, Ltd., in collaboration with Simon-Carves, Ltd., and for which Mowlem (Scotland), Ltd., is the civil engineering contractor. The Motherwell Bridge and Engineering Company, Ltd., is responsible for the metal fabrication work at this station, including the welding and erection of the pressure vessels and steam raising units. In connection with work of this nature, the fabrication of 3in thick steel plate to meet Lloyd's requirements for vessels demands exhaustive testing of design, materials, equipment and workmanship coupled with extremely close site control. For this reason it is of interest to note that before site welding was started, Motherwell Bridge and Engineering Company, Ltd., established a special welding school at Hunterston and initially some thirty welders were trained, tested and approved for working to meet the exacting requirements of welding 2⅞in plate for the 70ft diameter pressure vessels and other parts of the gas circuit.

A consideration of importance when site welding large vessels of thick section is the danger of brittle fracture which becomes greater as the plate thickness, depth of weld and corresponding stresses are increased. Although this risk is diminished when fabrication is completed, it is not entirely eliminated, since the vessels are pressure-tested while cold and during their life will probably be allowed to cool down at certain times from temperatures above the transition range at which fracture characteristics are altered. The problem is accentuated by the fact that intense radiation increases the transition temperature.

For the fabrication of the pressure vessels "Coltuf 28," a notch tough aluminium-killed low-carbon, high-manganese steel manufactured by Colvilles, Ltd., is being used. This steel possesses good notch ductility, i.e. it retains a high degree of ductility in the presence of notches at low temperature. It also possesses good welding properties, the carbon being held below 0·16 per cent. Plates of the thicknesses used at Hunterston have a tensile strength within the range 26–32 tons per square inch, the yield stress exceeding 16 tons per square inch. Elongation on 8in is 23 per cent minimum and the Vee-notch Charpy impact value at −10 deg. Cent. exceeds 35ft lb. These properties, combined with the low temperature at which transition from a tough fibrous fracture to a brittle type of fracture occurs, are attributable to the low carbon and high manganese content of the steel, the fine austenitic grain size, which is controlled to 6/8 on the A.S.T.M. scale by the addition of aluminium during manufacture, and the specially controlled heat treatment given to the plates.

Choice of the most suitable electrode to use with this steel was the subject of extensive research by G.E.C., and eventually there were specified "Diadem" opal electrodes manufactured by Cooper and Turner, Ltd., of Sheffield. On site the electrodes are stored before use in a heated store which is maintained at a constant temperature and they are carried during site use in "O.K." electrode driers or heated quivers made by Welding Supplies, Ltd. These quivers use current drawn from the welding supply line, to which they are connected by a single pincer-type contact, earthing being made by a magnet placed on the steel work.

Fabrication of component strakes for the spheres is being carried out in four 80ft diameter steel enclosures or dome covers located beyond the apron of the site welding shop. The six strakes required for each vessel include a bottom head, a 250-ton support course and grid, second, third and fourth tiers and a top head and inner shield components. Each of these strakes is welded under temperature controlled conditions in the enclosures, and the final circumferential welding of the strakes to form the spheres will take place inside the concrete biological shield of the reactors. A high degree of finish to welded surfaces is essential, not only for maximum clarity on X-ray examination but ultimately to remove any sources which may act as notches and cause cold cracking. This post-weld finishing is carried out with the use of "Hicycle" high-frequency electric grinders made by the Consolidated Pneumatic Tool Company, Ltd.

Among the services laid to the welding apron is a 1¼in propane line which carries gas from the two 10-ton liquid propane containers to preheaters which are situated in the enclosures and used to raise the temperature of the steel plate to a maximum of 350 deg. Fah. Other services include a 4in compressed air main which terminates in an 8ft receiver fitted with a check valve which allows a steady pressure of 95–100 lb per square inch to be maintained. A third service laid to the apron is the high-frequency electric supply, derived from a 20kW frequency changer located in a switch-room near the apron. This equipment has connections to eight six-point panels, allowing the simultaneous use of a large number of "Hicycle" high-frequency tools in the dome covers, mainly for grinding.

With "Hicycle" tools, utilising high-

frequency induction motors working on a three-phase circuit of 200 cycles at 125V, rotor speeds of 12,000 r.p.m. are obtainable, representing four times the power obtainable from a 50 c/s, three-phase source. The constant speed characteristic of the squirrel-cage induction motor gives the tools a speed drop rarely exceeding 10 per cent between free and fully-loaded conditions, and enables a high rate of metal removal with a relatively long abrasive life.

Final inspection of the welds in the 2⅞in steel of the pressure vessel is effected by X-ray machines of 400kV capacity. Four machines of this size are in use by the Motherwell Bridge and Engineering Company, whilst a further 300kV unit and three 220kV units are used in the main welding shop. These machines, manufactured and supplied to suit site requirements by Pantak, Ltd., of Slough, are considered to be probably the most powerful of their kind in operation in the world. The 400kV and 300kV units operate on a constant potential or double Greinacker circuit which, due to its small rectified "ripple" characteristic, ensures maximum penetration power for current used. Metal rectifiers are used to provide

Insulation of the steam raising unit vessels for stress relieving, using 4in thick rock wool

the required stable operating conditions allied with long life and to avoid need for valve replacements.

In these sets the lead shielded tubes are oil-cooled, a complete oil cooling system being maintained by a pump and coolers housed on a trolley carrying the generators. To prevent scatter and to ensure high definition of the radiographs, lead masks are placed between the tube and the work, the masks opening out to give a 1ft length of exposure. Lead shields are also placed behind welds when being inspected and this, together with the screening of the tube, allows work to be carried on within 15ft of the machine. The exposure time for a 2⅞in plate using a 400kV unit is 7 minutes using Kodak D film. Numbered head tags are placed on each section of the work for subsequent identification purposes.

The relatively short exposure time of 7 minutes obtainable with the 400kV units on 3in steel enables a high degree of sensitivity to be achieved, and even surface grinding flaws of the order of 1/300in are readily detected, in addition, of course, to the most minute welding flaws. Although 250kV machines could be used for this purpose, larger machines are specified to give the maximum clarity with minimum exposure time. Comparable exposure time for a 250kV machine on this work would be of the order of 20 minutes with corresponding loss of definition due to scatter and secondary radiation.

When assembly of sphere components is complete, stress relieving is carried out by radiant heaters supplied from a 4MVA transformer.

The welding shop in which the steam raising units or heat-exchangers are being fabricated consists of a double span building, each span being 180ft long, 82ft wide and 52ft high to eaves and served by a Carruthers "Goliath" crane. This building is flanked on one side by a 120ft by 15ft bay housing machine shops and the compressor house. For the nuclear plant sixteen cylindrical vessels, eight for each reactor, are being fabricated in this shop. Each vessel will be 73ft 6in high by 19ft 6in diameter, fabricated from silicon-killed carbon steel, and will weigh 200 tons. Six strakes, each composed of three segmental shaped plates, a bottom and top head and a supporting skirt, are required for each vessel. The welding of the strakes is carried out with two Quasi-Arc "Union-melt" boom machines, two welding heads being mounted on the boom of each machine. Single wire welding has been found to be the most satisfactory method at the site.

The larger of the two booms, believed to be the largest in the world, swivels through a full circle, and it can be used for internal welding up to 22ft and for up to 20ft when external welding. Both booms are built to traverse along on rails and each is fitted with remote control for manoeuvring purposes. The welding speed traverses available are variable between 6in and 60in per minute, and the machines have a rapid positioning traverse speed of 20ft per minute. Welding controls are provided at the welding head where the operator can work in either a sitting or a prone position in accordance with requirements.

Setting up and tack welding is carried out in the first bay, the strakes being moved to two sets of parallel rails in the second bay by way of Courtburn 40-ton rotator bed turntables for automatic welding. The ten motorised 40-ton capacity roller bed units provided for the purpose can be operated separately or ganged together in any number. An Asquith "R.G.2" horizontal drilling and boring machine has been installed for the drilling of holes for nozzles and connections in each heat exchanger. Provision is made in the welding shop for forty-two "Hicycle" power take-off points for the grinding and wire brushing tools used for weld preparation and for X-ray examination.

In the sequence of operations followed part-fabricated materials from Motherwell are assembled in Bay No. 1 into tier rings or heads and loaded on to the powered bogie units. These bogies carry the components to the "Union-Melt" welding heads where the longitudinal seams are completed internally and externally. On completion of this operation, the piece is moved to the X-ray location examined and manually repaired if necessary. On satisfactory completion of the examination, the piece, still on its powered bogie, is taken, via two sets of turntables, to a parallel location. At this point the circumferential welding is carried out and the complete shell is built up as each piece or strake arrives, welding and X-raying being carried on continuously.

The bottom and top head and supporting skirt are manually welded before being matched to the main cylindrical shell. The completed shell is then taken out on to the workshop apron and transferred by the 300-ton "Goliath" crane to idler bogies on the adjacent track on which it is traversed back into the workshop for the hand welding of the thermal sleeves, nozzles, branches, external and internal support lugs.

When the shell is ready for stress relieving, it is brought up against the end of a stress relieving furnace, where it is fitted with internal baffles to control the gas flow, and is lagged with 4in thick "Rocksil" rock wool by the Andersons Insulation Company, Ltd. As can be seen in one of our illustrations, the "Rocksil" is attached to shaped panel plates which are clamped together and sealed with due allowance for the expansion of the vessel. The stress relieving furnace is then coupled up to the blower mount nozzle at the bottom of the vessel and the other end

Grinding out a fault in a machine weld in a pressure vessel prior to hand welding. A propane preheating torch is in operation on the plate opposite the grinding point

is connected to the exhaust gas flue and chimney. After stress relieving has been completed a hydrostatic test, using sea water, is carried out and the vessel is cleaned.

The shell is then taken to the horizontal drilling and boring machine where the tube element holes in the ends of the thermal sleeves are jig drilled. At the same time, a butterfly cutting machine is spider mounted inside the vessel skirt to machine the flange face of blower motor nozzle square to the vertical centre line of the vessel. When the machine operations are finished, the internal structural parts are fitted to the vessel and are adjusted to ensure a good fit. These internal parts are then completely removed.

Final assembly is carried out under conditions of laboratory cleanliness and to

achieve these, a " clean conditions " chamber, which contains changing rooms, is connected to the bottom end of a vessel. Shot blasting, vacuum cleaning and " trilacing " are used in this cleaning stage ; in the meantime, the structural internal parts are cleaned separately. When these components are brought back through the " clean " chamber they are fitted into place without any cutting or welding. The vessel is finally vacuum cleaned before all its openings are sealed. It is then taken back out on to the apron and rotated to orient the fittings in relation to their final position with the reactor ready for transfer to site by the " Goliath " crane.

By the time the second of the two reactors goes critical in 1962, some 4500 tons of steel will have been welded in the course of the fabrication of the two pressure vessels, whilst the gas circuits and steam-raising units will have required the welding of over 4500 tons of steel and the emplacement of some 150 tons of weld metal. It should be mentioned that the project manager in charge of operations for the Motherwell Bridge and Engineering Company, Ltd., on the site is Mr. D. Stewart, and the chief resident engineer for the G.E.C. is Mr. D. W. T. Angwin.

Institution of Locomotive Engineers

On Tuesday last Mr. R. A. Smeddle, Chief Mechanical and Electrical Engineer, British Railways, Western Region, presented his presidential address to the Institution of Locomotive Engineers. Mr. Smeddle recalled experiences with the former North Eastern Railway and commented on some recent railway developments. We give here some extracts from the latter part of the address.

Coach Design

IN 1956 the first of the Inter-City diesel trains were built at Swindon and sent to Scotland to operate the hourly interval service between Edinburgh and Glasgow. For such main line fast services, it is necessary for the vehicles to be built to the same structural specification as the B.R. standard main line stock, i.e. all the vehicles must be provided with buck-eye couplers together with Pullman type gangways, and be capable of withstanding an end compression load of 200 tons applied to the end couplers.

In the standard B.R. all-steel coach, these requirements are met by a steel superstructure on a trussed underframe, the latter being alone capable of withstanding all the vertical loads and the 200 tons end compression load, without any assistance from the sides, roof or floor of the vehicle. To reduce the weight of the Inter-City diesel trains, and to provide the maximum space below the floor for the assembly and maintenance of the diesel equipment, the Inter-City cars were designed on the stressed body principle, in which the sides, roof and floor combine with the underframe to form an integral structure, all parts of which are stress-bearing.

The stress analysis of such a structure is very complex, and to prove the design procedure and ensure that the vehicles fully met the requirements of the specification for B.R. main line coaches, one of the Inter-City cars was sent to the S.N.C.F. testing station at Vitry, where it was exhaustively tested, in accordance with the procedure prescribed for International Coaching Stock. The tests included the recording of stresses by strain gauges at 248 places on the steel coach frame when subjected to :

(*a*) The maximum vertical static load which the coach has to withstand in service.

(*b*) 200 tons compression load applied at drawbar height through the end couplers.

(*c*) Oscillations of the vehicle when subjected to vertical and transverse vibrations were also recorded.

Under vertical loading, only two stresses in excess of 4 tons per square inch were recorded, the majority being of quite a low order, while under the compression load there was no permanent deformation at any part of the coach structure, all the stresses being within the elastic limit of the steel. In this connection it will be noted that the compression load of 200 tons is not one normally experienced under service conditions, but it is intended to ensure that the vehicles offer reasonable protection to the passenger in the event of collision, and, in these circumstances, it is permissible for the stresses to be higher than can be allowed for vertical loading which are attained under normal service conditions. During the tests accurate measurements were taken of the distortion of the coach body in such places as doorways, windows and body sides, and no unusually high deformations were recorded which would indicate particular points of weakness in the design.

The vibration of vehicles under service conditions is an important matter upon which more research is necessary by railway vehicle designers, and the tests carried out at Vitry were designed to provide data for such investigations. For the present it can be stated that the results of the vibration tests on the Inter-City car compare favourably with those of the other vehicles provided by various European Administrations for similar testing at Vitry.

The general conclusion which could be drawn from the tests was that the vehicles met the full requirements of the B.R. specification for main line stock, but there was scope for further reduction in tare weight, which could be achieved by a more critical analysis of the stressing throughout the vehicles. Investigations on these lines have continued and a basic design for a main line coach developed, on which the integral steel body will be nearly 2½ tons lighter than the comparable structure of the present standard B.R. coach.

The general improvement in the standard of comfort and in the amenities demanded by passengers, in the form of insulation, double glazing of windows, buffet facilities and improved ventilation, all have the effect of increasing the weight of our coaching stock, and when this is considered in the light of our efforts to improve train speeds and reduce our motive power costs to a minimum, the importance of any developments which can reduce the weight of our coaches at an economic cost becomes apparent. In this connection, it is interesting to see how the weight of a B.R. standard coach is built up. The weight of the steel structure which alone contributes to the strength of the vehicle accounts for only about one-third of the tare weight ; approximately another third is contributed by the bogies, while the remaining third of the weight is made up by the internal fittings, electrical equipment, brakework, heating and lavatory equipment.

It is evident that, apart from any reduction in tare weight, which can be achieved on the steel structure of the coach, efforts must also be made to effect reductions in the weight of the bogies and in the ancillary equipment. In the case of the former, economy in weight must be obtained with improved riding characteristics and reduced maintenance costs. Passenger comfort must not be sacrificed, and all weight reductions must be made with due regard to economic considerations.

New Dynamometer Car

Recent years have seen a very considerable advance in testing techniques as exhibited particularly in the development of the Swindon controlled road testing system. New methods of measurement and recording have become available ; indeed, these have been found essential to the solution of problems arising with the new forms of motive power. The Western Region dynamometer car was constructed in 1901 and has been in use for all this time, so it was decided to replace it by a more modern vehicle and to take advantage of the latest techniques.

Its equipment will be able to present all the essential measurement data under the actual running conditions and in a form which will permit of rapid and critical appraisal. It will provide an example of the adaptability of electronic methods of traction and associated problems. Drawbar pull, for instance, will be measured by strain gauge transducers in three load ranges. The highest range has a capacity more than equal to the highest efforts that can be, or are likely to be, exerted by locomotives in this country. These transducers will be capable of being transferred from the drawgear at one end to that at the other, and so avoid having to turn the car. Tractive effort/speed curves and speed/distance/time curves will be produced automatically by means of suitable transducers and servo-motors.

Diesel-Hydraulic Locomotives

You will probably expect me to say something about the Swindon built 2000 h.p. diesel-hydraulic locomotives of which ten are now in service. Whilst in the early days of modernisation, the tendency generally on British Railways was to develop designs for diesel-electric locomotives, the Western Region management was considering the possible advantages of the hydraulic transmission and it was decided, with the concurrence of the British Transport Commission, that this Region should, in fact, take the initiative in exploring the possibilities in this field.

Whilst I do not intend to intervene in the conflict of opinion in regard to the advantages and disadvantages of electric transmission, a preliminary examination seemed to indicate that whilst electric transmissions had given satisfaction for many years and were still favoured by many railways, the advent of the hydraulic transmission for main line locomotives had to some extent changed the position. In particular, it was thought that its low weight, especially if used in conjunction with the low weight, high speed diesel engine and a lightweight form of locomotive construction, would show economies in operation. It was also thought that obviating the intermediate electrical energy stage of the diesel-electric locomotive must be a step in the right direction provided that the hydraulic transmissions as at present developed were reasonably robust and reliable. Experience

in Germany on quite a large scale furnished evidence that this was so, and it was decided, therefore, to build a number of diesel-hydraulic locomotives for service on the Western Region.

Three basic types were initially proposed : (1) A 2000 h.p., four-wheeled bogie locomotive with Maybach engines and Mekydro transmissions to be designed and built at Swindon ; (2) A 2000 h.p., six-wheeled bogie locomotive with M.A.N. engines and Voith transmissions to be designed and built by the North British Locomotive Company ; (3) A 1000 h.p., four-wheeled bogie locomotive with M.A.N. engines and Voith transmissions to be designed and built by the North British Locomotive Company.

The Swindon locomotive was to be based on the German " V.200," designed by Krauss-Maffei at Munich, as this design was thought to be of considerable merit, particularly as its weight was less than 80 tons for a horsepower of just over 2000. The major problem in this case was to accommodate all equipment, or its equivalent, of this German locomotive in another one which had to be 10in less in height and 16in narrower, such limitations being imposed by the British Railways load gauge. The low weight has been achieved partly by using the Krauss-Maffei design principle. The underframe consists basically of two steel tubes, 6½in in diameter, running the whole length of the locomotive between the buffers, the centres of these tubes coinciding approximately with the buffer centre lines. Deep longitudinal plate members provide strength from the bending point of view and for the traction force, these members and the tubes being connected by transverse plate members, the whole being welded together.

Future of " Dieselisation "

But what of the future, in particular, the change over to "dieselisation?" So far as locomotives are concerned, will the high-speed lightweight engine or the slow-speed medium weight engine ultimately find favour ? Similarly with the transmissions, will hydraulic types continue to make progress in power and number ?

I would make a plea for greater simplification, particularly as regards the auxiliary equipment, control gear and the various protection devices. In practice it has been found that the latter devices can cause unnecessary shut downs due to defects in the device itself. Whilst they undoubtedly would and do function satisfactorily under static conditions, a much more robust design is required of those to be placed on locomotives. Weight is also an important consideration, as instanced by the two types of 2000 h.p. main line diesel locomotives on the Western Region, one weighing 78½ tons and the other 117 tons. It is obvious that on any route the first locomotive will be able to haul an additional 40 tons.

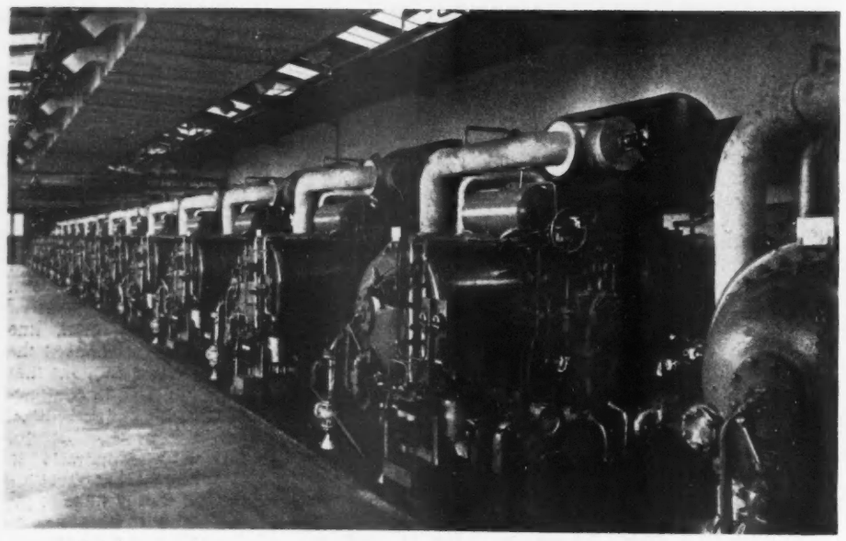
Once through with the initial stages, involving many complex problems usual to a change over on such a scale, " dieselisation " should prove to be a paying proposition.

Wilton Works Extension

A third olefine plant is now on stream at the Wilton Works of I.C.I., Ltd. The Tees-side complex of this company is now the largest of all petroleum chemical ventures based on liquid feedstock.

THE tenth anniversary of the Wilton Works of Imperial Chemical Industries, Ltd., on the Yorkshire bank of the Tees, was celebrated by the starting up of the third olefine plant operated on the site by the Heavy Organic Chemicals Division. The new plant increases the company's olefine capacity by more than 50 per cent, the output of the chief product, high-purity ethylene, being now about 110,000 tons per year. A by-product of the plant is a high-quality gasolene.

The new plant is basically similar to the existing two units at Wilton being built by the Kellogg International Corporation to the designs of the M. W. Kellogg Company. All three run on light naphtha, a straight run distillate of crude petroleum, which is delivered by ocean tankers to Teesport. The Kellogg method of pyrolysis involves bringing superheated oil vapour into contact with high-temperature steam for an interval of the order of one second. The oil and water heaters, running at over 1000 deg. Cent., are plant which may require maintenance, particularly decarbonisation of the tubes of the oil heater, and consequently three complete sets of heaters, each with its own soaker in which the hot vapours react, are installed. Each pyrolysis section ends in a quench boiler, where the products are cooled and steam at 250 lb per square inch is evolved for supply to the superheater. A single primary fractionator accepts the pyrolysis products and separates out the water and the small content of heavy oil, which is used as fuel.

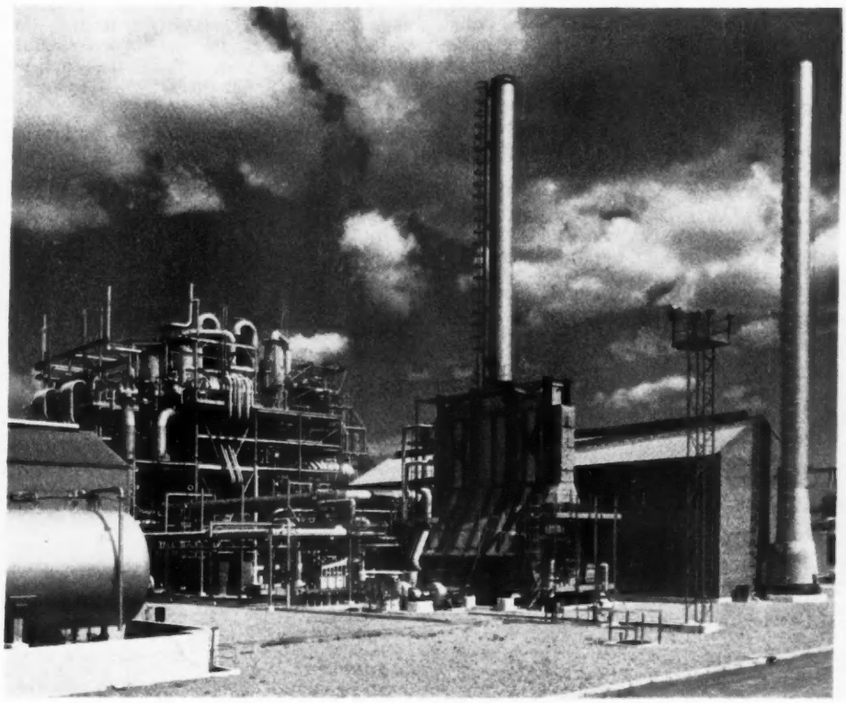


The plant is intended to remain on stream for two or even three years, and hence the compressors are driven by low-temperature turbines supplied from a battery of fifteen gas generators

The gas separation section is intended to run continuously for two or even three years. For this reason, it is powered by low-temperature gas turbines and the turbines are fed from a large battery of free piston gas generators. The generators are the well-known inward-compressing machines of the Société Industrielle Générale de Mécanique Appliquée, and thirteen of the units are of S.I.G.M.A. manufacture. Three more machines, to make up the total of fifteen installed and one spare, were supplied by the Free Piston Engine Company. The generators run on residual fuel ; it is expected that this power installation will show economic advantages, but the operators have not yet acquired sufficient experience to state whether this is so.

Brush turbines are used, regulated when under load by a multiple butterfly valve consisting of the turning vanes in the bend below the turbine. The linkage for these vanes runs at close to gas temperature, and is lubricated with a silicone-based oil loaded with molybdenum disulphide ; it is also cowled in and forced air cooled. The control vanes are driven by Hobson hydraulic motors and the system senses compressor intake pressures, except that turbine speed detectors are included to protect the plant from damage.

The centrifugal compressors are handling a highly combustible gas, and, consequently, oil-packed glands separate the gas spaces from the atmosphere. In the case of compressors used for refrigeration, leakage of oil inwards is to be avoided, since the oil would become extremely viscous in the low-temperature spaces and its harmful effects on the heat exchange would be difficult to rectify. For refrigeration duties, therefore, Carrier compressors with face seals finished plane within four light bands are used. The vapour used for refrigeration is itself ethylene ; the lowest temperatures reached in the gas separation process are attained by expanding the process gas itself, allowing hydrogen and methane to be drawn off—since the separation starts at minimum temperature, what is conventionally " tail gas " is the first separation. The small content of acetylene has previously been removed by hydrogenation to ethylene over a catalyst newly developed by I.C.I. The hydrogen and " C_1 " compounds are pumped through a tunnel under the Tees to Billingham, where they are divided between two other divisions of the company, General Chemicals Division converting them into hydrogen cyanide, and Billingham Division into mixed hydrogen and carbon monoxide. The " C_2 " stream consists of ethylene, 90 per cent of which is piped to the neighbouring plants of Plastics



A pair of oil heaters and steam heaters, soaker lines and primary fractionation equipment

Division for processing to polythene, while the remainder remains with the Heavy Organic Chemicals Division and becomes ethylene oxide. The "C_3" product, mostly propylene, is piped across the river for the manufacture of isopropanol and butanols by H.O.C. Division, but a projected plant at Wilton will purify this product to allow polypropylene to be prepared by Plastics Division. At present some of the "C_3" compounds, together with some of the "C_4," is sold as liquefied petroleum gas. The remainder of the "C" stream goes to the H.O.C. Division butadiene plant at Wilton.

"Sovereign" Class Medium Powered Diesel Engines

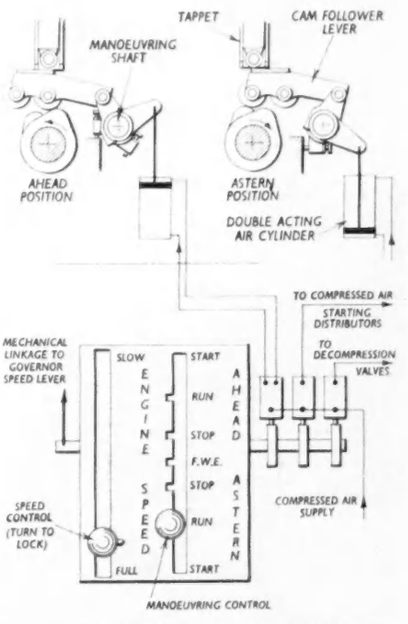
A study of the power requirements of the new designs of near-water trawlers and similar craft has resulted in the National Gas and Oil Engine Company, Ltd., producing a modified version of its "F4A" engine. In its new form the engine is a direct-reversing unit, either normally aspirated, turbo-charged, or turbo-charged with intercooling, and is available with six, seven or eight cylinders. The six-cylinder engine develops 500 b.h.p. at 300 r.p.m., with a brake mean effective pressure of 130 lb per square inch.

CHANGES in the overall design of the hull and in the specification of the machinery of the near-water trawlers are being incorporated in the new vessels now being built or being ordered for the Aberdeen and Lowestoft fleets. Based on an assessment of the specific requirements for the main propulsion units of trawlers, tugs and small coasters, the National Gas and Oil Engine Company, Ltd., decided to produce, in close association with the owners concerned, a modified version of its well-proved "F4A" uni-directional engine. The design now provides for a direct-reversing unit under full governor control and is available as a vertical, in-line, four-stroke, single-acting, normally aspirated, turbo-charged or turbo-charged with intercooler engine with six, seven or eight cylinders. Named the "Sovereign" class, the engine has a bore of 12in and a stroke of 15in, and a compression ratio of 13 to 1 when normally aspirated, and 12 to 1 when turbo-charged. The continuous rated power of the engines over the speed range is set out in the accompanying table :

R.p.m.	Number of cylinders			B.m.e.p., pounds per square inch
	Six	Seven	Eight	
Normally aspirated :				
300	342	399	456	88·5
400	456	532	608	88·5
500	570	665	760	88·5
600	637	743	849	82·0
Turbo-charged :				
300	468	545	624	121·0
400	624	727	832	121·0
500	780	910	1042	121·0
600	890	1040	1188	115·0
Turbo-charged with intercooler :				
300	515	600	685	133·0
400	685	800	915	133·0
500	857	1000	1142	133·0
600	1030	1200	1372	133·0

To ensure that the engine requires the minimum maintenance and, therefore, provide the maximum availability, the scantlings are robust and the main constructional parts are one-piece castings of cast iron. Rigid columns are mounted on the bed-plate and the whole arrangement results in a rugged engine frame which damps vibration and makes for quietness in operation. Four compression and two scraper rings are fitted to the cast iron pistons, which are oil-cooled and have floating pins. The cooling oil is delivered through a passage, drilled through the connecting-rod, to the cooling chamber under the piston crown and returns through pipes which discharge into a collector. From the collector a pipe returns the oil to the crankcase via a sight glass mounted on the crankcase door. High-grade white-metal, steel-backed bearing shells carry the crankshaft, which, although it has scantlings in excess of Lloyd's requirements, receives no special treatment. A seal is fitted at each end of the crankshaft to prevent any ingress of sea water.

Gears from the flywheel end of the crankshaft drive the camshaft, which is carried in generously proportioned split white-metal bearings. Although two sets of low-lift cams are mounted, thus limiting the space taken up by the manœuvring gear, adjustable timing for the fuel cams has been retained in order to achieve maximum performance. The valve gear, which gives a two to one increase in lift, is mounted on the cast iron cylinder head and consists of four valves, the exhaust valves being in cages as part of the scheme to facilitate maintenance operations. Also fitted to the cylinder head are the fuel injector, cylinder relief valve and maximum pressure indicator cock, together with a decompression valve, the purpose of which is to reduce the time taken for reversing from ahead to astern or vice versa. The



Engine control and reversing mechanism

design of the head ensures the isolation of the injector from the pressure lubricated valve gear so that there cannot be contamination of the lubricating oil by fuel oil or dilution of fuel by lubricating oil. Additionally, the fuel pumps are outside the crankcase so that the fuel system is separated from the lubricating oil. There is a jerk pump to each cylinder and the oil fuel system incorporates Vokes filters.

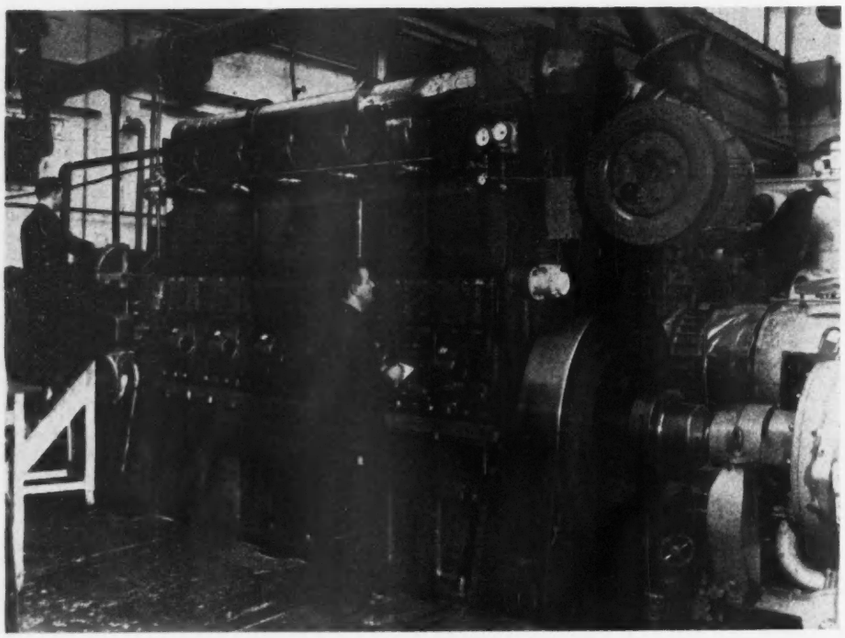
We recently had the opportunity of visiting

the works of the National Gas and Oil Engine Company, Ltd., to inspect a six-cylinder turbo-charged and intercooled unit on the test bed, and to witness typical maintenance operations being carried out on a similar engine. These include the removal and return of a piston and connecting-rod through a crankcase door without disturbing the cylinder head, each operation being timed to take a maximum of thirty-five minutes. We include a general view of the engine, and also a typical set of performance curves.

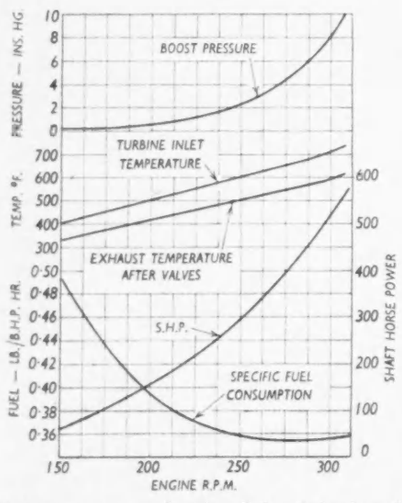
A "Brush" turbo-charger is fitted and a Serck intercooler, and the engine has a Curtiss-Wright hydraulic governor, which responds rapidly to small changes in speed and provides stability against surging or hunting. Salt water is the cooling medium for the intercooler, oil cooler and the main engine heat exchanger and passes through each of these before being discharged overboard. The engine is fresh water cooled.

Special attention has been paid to the design of the engine controls and reversing mechanism and to the means whereby the engine can be slowed down, in the minimum of time, to enable the mechanism to be operated. The controls, which are located at the opposite end to the flywheel, are simple, and changeover from full speed ahead to full speed astern can be completed within ten seconds. This is achieved by the locating tappets between the "ahead" and "astern" cams, the cam motion being transmitted to the tappet by the cam follower lever. This follower has "offset" rollers each in line with one of the cams and a compressed air cylinder on the manœuvring shaft supplies the power necessary for the movement from the "ahead" to the "astern" position, so that the minimum of effort has to be applied to the control lever. From the diagram on page 311 it can be seen that the engine control and reversing gear consists of two levers, one of which is mechanically linked with the engine governor, whilst the other controls the valves supplying compressed air for starting, stopping and manœuvring. To reverse the engine the speed control lever is moved to "slow" and the manœuvring lever moved from "run" to "stop," when the decompression valves open and the fuel is shut off. After the engine revolutions have dropped to 100 r.p.m. or less then the manœuvring control is moved to "start astern," to admit starting air and open the fuel rack, and then when the engine fires the control is moved to "run" and the speed control adjusted as required. The company considers the system to be foolproof and to demonstrate its faith in the simplicity of the controls several of the guests were invited to operate the gear.

A number of six-cylinder engines are on order and one has been installed and the National Gas and Oil Engine Company, Ltd., is arranging for full engine service facilities, together with supplies of spares, to be available at Aberdeen, Hull, Grimsby and Fleetwood and elsewhere as circumstances warrant.



Six-cylinder, turbo-charged and intercooled "Sovereign" class diesel engine



Performance curves of a six-cylinder, turbo-charged and intercooled "Sovereign" class engine

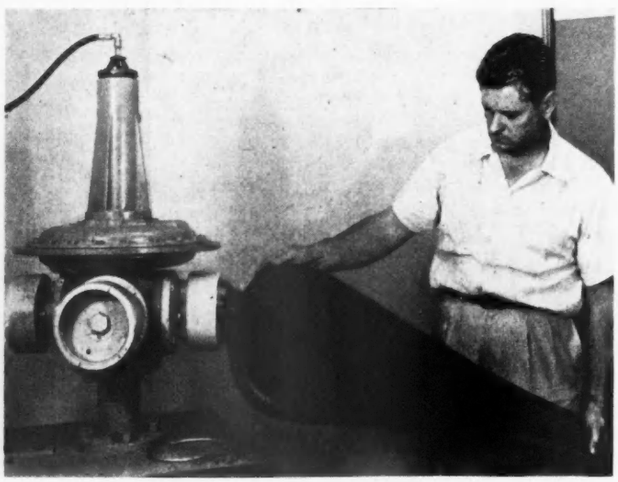
Variable Pitch Fans

We learn that Marston Excelsior, Ltd., a subsidiary company of Imperial Chemical Industries, Ltd., has acquired from the Hudson Engineering Corporation of Houston, Texas, the sole right to manufacture Hudson hollow plastic industrial fans in the United Kingdom. The fans will be sold under the trade name "Marex."

Initially, the standard range will consist of four-bladed fans ranging from 6ft to 14ft in diameter in increments of 2ft. A set of hollow plastic blades may be fitted to alternative hubs, either the auto-variable hub, which by means of a pneumatically energised diaphragm alters the angle of pitch while the fan is in motion, or the adjustable pitch hub, which requires that the fan be stopped while a simple manual alteration of pitch is carried out. On both hubs the angle of pitch may be varied between −15 deg and +30 deg.

The advantages of these fans over conventional wooden and metal fans lie in the materials, method of construction and the aerofoil shape. Blades are made of woven glass cloth and pigmented epoxy resin, laminated as a one-piece moulding. These materials form a self-coloured blade which is corrosion- and heat-resistant, while the method of construction gives blades of smooth surface, high strength and low weight. They will not shatter or fragment and, being hollow, are extremely light; a set of blades for a 10ft diameter fan weighs 58 lb. Fan blades of the same size are readily interchangeable as all blades are balanced at the works to a standard moment.

Installations in America and in this country are, it is claimed, giving entirely satisfactory service moving hot dry air through heat exchangers in desert areas, moving hot moist air from water cooling towers, moving corrosive laden air from chemical process vats, and activating large volume ventilation systems.



Fitting a blade on the pneumatic controllable-pitch fan

Technical Education at Rugby

EXTENSIONS to two educational establishments in Rugby were formally opened by the Minister of Education, Mr. Geoffrey Lloyd, on September 11. In the morning the Minister visited the new education building for apprentices of the British Thomson-Houston Company, Ltd., and in the afternoon he opened the new buildings of the Rugby College of Technology and Arts.

Rugby College of Technology and Arts

The Rugby College of Technology and Arts has grown considerably in size and stature since its early days after the first world war. At first the college was housed in old farm buildings. It was in the mid 'thirties that the main college buildings, around which subsequent growth has taken place, were planned and the first stage was built in 1941. No further building was done on the site until after the war and it was 1951 before the work was completed.

The College can claim to be the only surviving embodiment of a Day Continuation School established in accordance with the Education Acts of 1918 and 1921. But it is, of course, much more than that. For, with the co-operation of local engineering firms, it has been able to provide for more advanced education and in the 1956 White Paper on Technical Education the College was recognised as one of the twenty-four institutions that were concentrating on advanced courses.

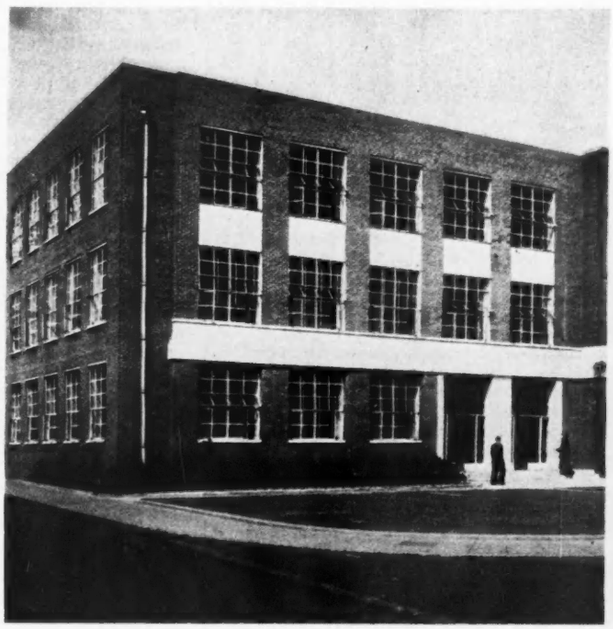
In the meantime, however, the demand for the training of technologists in increasingly large numbers foreshadowed fundamental changes in the structure of the college. Hitherto it had been possible for one such institution in Rugby to cater for the requirements of the area. In 1953 the governing body with the full support of the two main local firms—the British Thomson Houston Company, Ltd., and the English Electric Company, Ltd., started a system of sandwich courses for apprentices training for professional qualifications and for the London external B.Sc. degree in engineering. The Rugby college thus had a guaranteed annual intake of industry-based students. If it was to provide for their needs without neglecting its equally valuable work in part-time training in engineering at lower levels, it was clear that the college must be split into two institutions.

Accordingly next year the present establishment will be divided into two separate colleges —each with its own governing body. One will be known as the Rugby College of Engineering Technology : it will be a full-time residential college for Diploma of Technology (Eng.) and for degree courses, and will occupy the existing building.

The day continuation school and the art, commerce and housecraft departments, together with part-time students, will vacate this building and will occupy the present Rugby High School building and the recently completed machine shop and the nearby three-storey block. This establishment will be known as the East Warwickshire College of Further Education.

With this transfer and the new buildings the Rugby College of Engineering Technology should gain the space, amenities and environment that are desirable in an establishment for diploma and advanced studies. The new buildings consist of an assembly hall, common rooms for staff and students, library, dining hall and kitchens, and two halls of residence which are believed to be the first of their kind to be built at a technical college on behalf of the local education authority.

In a speech at the opening ceremony Mr. Lloyd, the Minister of Education, said that new technical college buildings were being opened at the rate of one a week. The number of sandwich courses had grown from seventy in 1955 to over 300 in the present session. The number of students taking these courses was increasing even more rapidly. For example, in the Diploma in Technology courses there were 137 students in the final year, this summer, but nearly 1200 in their first year, and this country was moving very fast towards her immediate aim of doubling the output of scientists and technologists by the late 1960s. But it was not merely a question of multiplication of courses and students. The new college viewed scientific and technical studies as no more than part of education of complete men and women capable of playing a leading part in the future development of British society.



Education building of the British Thomson-Houston Company, Ltd., Rugby

After the opening ceremony the laboratories were open to the guests. Perhaps the most vivid impression we retained after a brief tour of some of the engineering laboratories was of the emphasis that appears to be put upon visual aids in laboratory demonstrations and experiments. For instance, in the mechanics-of-fluids laboratory we saw two rigs, each consisting of a transparent-sided channel forming part of a closed circuit with pumped water to demonstrate the flow of water—in one case through a Venturi flume and, in the other, over a broad crested weir. There was also a small wind tunnel compactly arranged to give visual demonstration, by smoke trails, of air flow over an aerofoil and by a manometric array, of the pressure distribution over the aerofoil surface.

We learn that the British Thomson-Houston Company, Ltd., contributed towards the cost of the building and donated laboratory equipment, while the English Electric Company, Ltd., made the gift of a water turbine and bore the cost of its installation.

B.T.H. Education Building

The B.T.H. education building is the administrative centre of the company's educational work and it serves the A.E.I. product divisions that are managed by B.T.H. and have their departments situated in Rugby, Birmingham, Coventry, Leicester, Chesterfield, Newcastle (Staffs) and Lincoln.

It administers the education of more than 2000 apprentices as follows : graduates, 146 ; students, 333 ; technicians, 720 ; craftsmen, 894. Much of the effort of the education department is concerned with the company's sandwich scheme, started in collaboration with the Warwickshire Education Authority in 1953. The number of sandwich course students is 320 at present (1959 intake 90) and is expected to rise to about 500 in 1962.

For professional qualifications there are two alternative goals : The London external B.Sc. degree in Engineering and, more recently, the Dip. Tech. The first Dip.Tech. course in electrical engineering at the Rugby College of Engineering Technology, has just started its first session and includes about thirty B.T.H. students.

The new education building (illustrated here) is annexed to the company's headquarters building at Rugby. It has a spacious entrance hall and reception area in which there is a permanent display of some of the company's products. One of the historical exhibits is illustrated below. On the first floor are the offices of the manager of the education department and of his staff.

The Minister of Education, Mr. Geoffrey Lloyd, with Lord Chandos, chairman of A.E.I. inspecting the rotor of a Whittle jet engine in the B.T.H. education building

On the second floor are two lecture rooms (accommodating eighty and fifty students respectively) and two tutorial rooms for group studies. There is also a training drawing office and we were interested to learn that about 15 per cent of the drawing office course is devoted to a study of "appearance design"; this part of the curriculum was started five years ago and models made to the three winning designs for this year's study (a 5 h.p. direct-on-line starter) showed a good appreciation of the subject.

The building is designed to allow for extensions that will accommodate a training drawing office for 100 boards and a lecture room for about 250 students.

SHORTER REPORTS

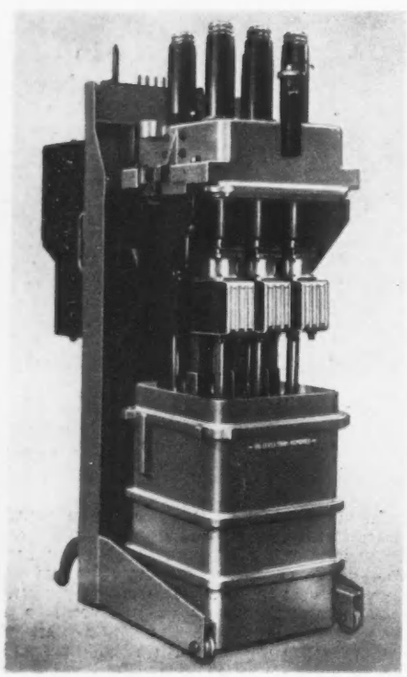
Improved Oil Circuit Breaker

A NEW oil circuit breaker, which has recently completed a comprehensive series of tests at the K.E.M.A. laboratories in Holland, is announced by Johnson and Phillips, Ltd., Charlton, London, S.E.7. It is a double-break design, with improved cross-jet arc-control system and can be incorporated into standard J. and P. metal-clad, vertical isolation draw-out switchgear (with air-insulated or compound-filled busbars), which is only 1ft 9in wide. K.E.M.A. certificates have been issued for the following rating capacities :— 350MVA at 11kV, 250MVA at 6·6kV and 150MVA at 3·3kV. To meet certain overseas requirements the circuit breaker has also been tested for 250MVA at 13·8kV. The current ratings are 400A, 800A and 1200A.

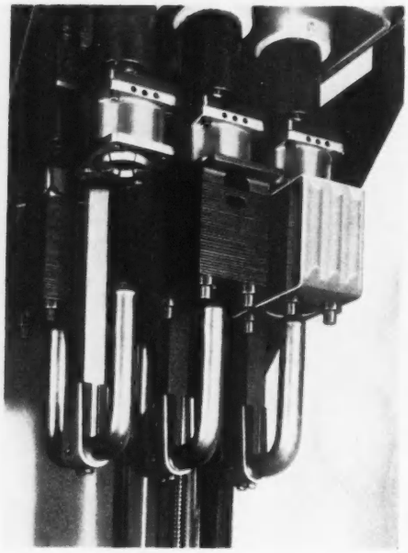
The reason for developing the new PDB breaker was to rationalise as far as possible the company's production of h.v. metalclad switchgear made at New Cross and to increase the rupturing capacity with a minimum of retooling —an important consideration, particularly in the manufacture of such switchgear in J. and P. factories overseas.

For many years the company has offered two interchangeable oil circuit breakers for use in their standard air-insulated and compound-filled metalclad switchgear : a plain double-break circuit breaker known as DB 16, and a single-break circuit breaker with arc-control devices, known as the SB 16. By its nature the single-break breaker was limited to 6·6kV and 11kV, and some eighteen months ago the company decided to increase the range of the double-break breaker to 150MVA at 3·3kV and to 250MVA at 13·8kV.

The new breaker uses the same top plate, insulators and many of the components that are used for the DB 16, but covers the wide range of breaking capacities and voltages given above. In addition, the 800A PDB circuit breaker has been successfully tested at 350MVA, 11kV, with porcelain bushings.



PDB 1200A arc-control circuit breaker with tank lowered. Certified breaking capacities 150MVA at 3·3kV, 250MVA at 6·6kV, 250MVA at 11kV, 350MVA at 11kV. Also tested for 250MVA at 13·8kV



PDB 1200A circuit breaker partly dismantled to show arc control pot and contacts

Considerable standardisation between the plain-break breaker and the arc-controlled breaker has been achieved ; the same operating mechanisms are employed and the plan dimensions of the tank are unchanged. Therefore, it is simple to replace a plain-break circuit breaker (having interrupting capacities limited to 150MVA at 6·6kV and 11kV or 100MVA at 3·3kV) with the new PDB circuit breaker of much greater interrupting capacities, i.e. 350MVA at 11kV, 250MVA at 6·6kV and 150MVA at 3·3kV.

The new PDB oil circuit breaker replaces (and is dimensionally interchangeable with) the TSB circuit breaker previously employed, for rupturing capacities up to 250MVA at 11kV, in J. and P. metalclad gear.

The moving contacts are of solid round copper rod which make into fixed contacts consisting of a circular configuration of finger contacts (as illustrated), backed by helical springs. In this illustration the arc-control pot is shown complete on the right-hand phase. On the central phase the glass fibre baffle is removed to show the vent ports ; its function is to deflect the blast equally in opposite directions at right angles to the axis of the ports and thus to neutralise the reaction and the stress on the insulator. The arc-control pot is removed from the left-hand phase to show the fixed contact system. A buffering system is incorporated to cushion the moving contacts when the breaker opens under fault conditions.

Depending on the current rating of the breaker, the top plate is of cast aluminium or fabricated steel plate, with non-magnetic inserts between the bushings. The tanks are fabricated from steel plate suitably proportioned to withstand the internal pressures resulting from fault clearance. The three phases are segregated from each other within the tank by barriers of rectangular formation. The top plate is designed to form a complete housing for the contact lifting mechanism of the breaker, which consists of a simple bell-crank arrangement, and to provide a suitable expansion chamber for cushioning the impulse pressures set up under short-circuit conditions. The toggles needed to reduce the forces of tripping are contained in the external operating mechanism and not in the breaker.

The terminals are carried in porcelain insulators or synthetic-resin-bonded paper bushings, cemented solidly into stiffening tubes welded to or cast in the top plate. The terminals can be either the bolted or plug type, as required, and conversion from one to the other is simple. Cast epoxy resin bushings can be supplied if required.

Solenoid, power-spring, or spring-assisted-manual operating mechanisms are available to suit the various ratings. The power mechanisms are interchangeable and a spring-closing device can be replaced by a solenoid magnet without disturbing the main operating mechanisms. All mechanisms are of free-handle design, arranged to accommodate overload, shunt and earth leakage trips.

The tests carried out at the K.E.M.A. laboratories were exhaustive and exceeded the requirements of B.S. 116 : 1952, which, in its present form, only requires the performance of the breaker to be proved for three-phase faults which may or may not be connected to earth. Each phase of the PDB breaker was successfully tested to earth separately at full power to demonstrate the ability of the equipment to withstand the asymmetrical internal stresses set up in conditions typical of line-to-earth faults.

One of the characteristics of the breaker revealed in the testing was that at all short-circuit ratings (even down to 2½ per cent of its full rating) the whole arc was confined within the arc-control device, making control of the arc more positive. A more common experience is that at low ratings the pressures within the arc-control device fail to rise enough to extinguish the arc while the contacts are still inside the device.

Motor Vehicle Modifications

ALTERATIONS to their ranges of passenger cars have been announced by Rolls-Royce, Ltd., and Ford Motor Company, Ltd.

An o.h.v. " V-8 " engine of 6230 c.c. replaces the i.o.e. in-line six of the " Silver Cloud " and " S " series Bentley cars, and powers a new model, the " Phantom V " limousine. The new engine, the block and heads of which are cast in high silicon aluminium alloy, is the first Rolls-Royce push-rod " V-8 ," the " Legalimit " having been side-valve and the " Meteorite " having an overhead camshaft on each bank. Such engines are, however, well established for use in conjunction with automatic transmission, and the Rolls-Royce " Hydromatic " gearbox is standard in all the cars. The engine has a bore and stroke of 4·1in by 3·6in, and the compression ratio is restricted to 8 : 1 in the interests of silence and smoothness. The tappets are hydraulic, and fed with the full pressure of the helical-gear pump.

The detergency of the oil is found not to be critical, and is at the operator's discretion : mixed-viscosity oil is acceptable. The oil change interval is 2500 miles, with filter element changes at 5000 miles. The distributor has twin contact breakers, each handling four cylinders on the usual two inner, two outer distribution, and hence synchronism, or rather anti-phase, of the breakers must be maintained with extreme accuracy. The two S.U. carburetters employ diaphragms to drive the needle blocks. It is of interest to note that the complete assembly of crankshaft, connecting-rods and pistons is balanced by motoring it in the crankcase and observing out-of-balance electrically.

The " Phantom V " takes the place of the " Silver Wraith " in the Rolls-Royce range, and will be available only with coachbuilt bodies : it has a wheelbase of 12ft and an overall length of 19ft 10in. (The " Silver Cloud " has dimensions of 10ft 3in and 17ft 8in, or 10ft 7in and 18ft in long wheelbase form.) The turning circle is 48ft 9in to the outside edge of the tyre

only. Compared to the saloon, the tyres are larger, 8·90 by 15 instead of 8·20 by 15, and the final drive lower, 3·89 instead of 3·08: an engine speed of 1000 r.p.m. corresponds to a road speed of 22·5 m.p.h. in top. The mechanical details of the chassis are the same, the axle being semi-floating, and there being twenty-one grease nipples.

The existing Ford "Popular" and "Anglia" models have been discontinued, and the two-door model 100E has been designated the "Popular." It is available in both standard and de luxe forms: its appearance differs from the earlier car in that the tail light, turning indicator, and reflector are separate. The instruments are concentrated in front of the driver on a hooded panel. The car has the wide-ratio gearbox (second 2·01, first 3·9) originally introduced on the 300E "Thames" vehicles.

Inertial Navigation Instrument Production

A NEW £150,000 extension to the existing laboratory of Ferranti, Ltd., at Crewe Toll, Edinburgh, was opened earlier this month by Mr. Aubrey Jones, the Minister of Supply. The extension will be used for the production of a new series of high-precision gyroscopes and accelerometers for inertial navigation systems used in aircraft, missiles and other vehicles. An additional floor area of approximately 17,400 square feet is provided by this new single-storey building, comprising machine and process shops, assembly and test areas, stores, laboratories and offices.

In the manufacture of instruments for inertial navigation, it is imperative that no dust particles greater than about 0·5 micron in size, or excess moisture, should be present in the assembly area. For this reason the assembly and inspection areas and the store room for finished parts are temperature, humidity and dust-controlled. To ensure that machined components do not carry any particles of dust, &c., from the machine shop into the clean areas, there is a system of double air locks between the machine shops and a special cleaning room equipped with ultrasonic cleaners. A second double air lock between the cleaning room and the air conditioned store room ensures the minimum transfer of air and hence dust, between the conditioned and non-conditioned areas.

The clothing issued to operatives is made of lint-free materials. In the two "blowing rooms" the theoretical velocity of the filtered air, when a man is passing through the room, is about 30 m.p.h. Air locks have been provided at the entries and exits to these "blowing rooms," so that draughts from them do not disturb the air in the clean area. Whilst going through these rooms, the operatives' clothes are subjected to considerable agitation and dust particles are exhausted through the floor grilles. To eliminate vibration, air conditioning is by an absorption cooling machine of sufficient capacity to provide cooling water for both the main plant and the plant installed for the changing rooms. The temperature is controlled at a dry bulb temperature of 72 deg. Fah., plus or minus 1 deg. Fah., at eight points of control within the air conditioned areas, and draught-free diffusion of air is obtained by means of perforated dome-type secondary air diffusers placed continously across the ceiling.

Special precautions have been taken to isolate ground transmitted vibrations from the test area. In a pit underneath the main floor of the test area, there are three large reinforced concrete blocks. The first of these weighs about 60 tons and the other two about 40 tons each. The large block, and one of the small blocks, are each mounted on four rubber pads and are also fitted with rubber side buffers which give the necessary isolation of vibration in the vertical and horizontal planes respectively. These two blocks, the tops of which come to within about 12in of the underside of the suspended flooring over the pit area, carry a number of aluminium alloy pillars filled with concrete, each weighing approximately 1 ton, which pass through the flooring. A flexible dust seal is fitted between each pillar and the floor so that no vibration is transmitted from the floor. The third concrete block carries one test pillar only and is suspended on sixteen helical coil springs, thus giving better isolation from disturbance than on the other two. Damping is achieved by dashpots filled with silicone oil.

Demonstration Van de Graaff Generator

A VAN DE GRAAFF generator suitable for classroom use and for demonstrations of the principles of electrostatics has been shown at the Scottish Industries Exhibition, Glasgow. This electrostatic generator is made by W. B. Nicolson (Scientific Instruments), Ltd., Thornliebank Industrial Estate, Glasgow. It consists of a hemispherical base supporting a 10cm diameter transparent insulating tube on which is mounted the top electrode in the form of a highly polished hollow aluminium sphere, 30cm diameter.

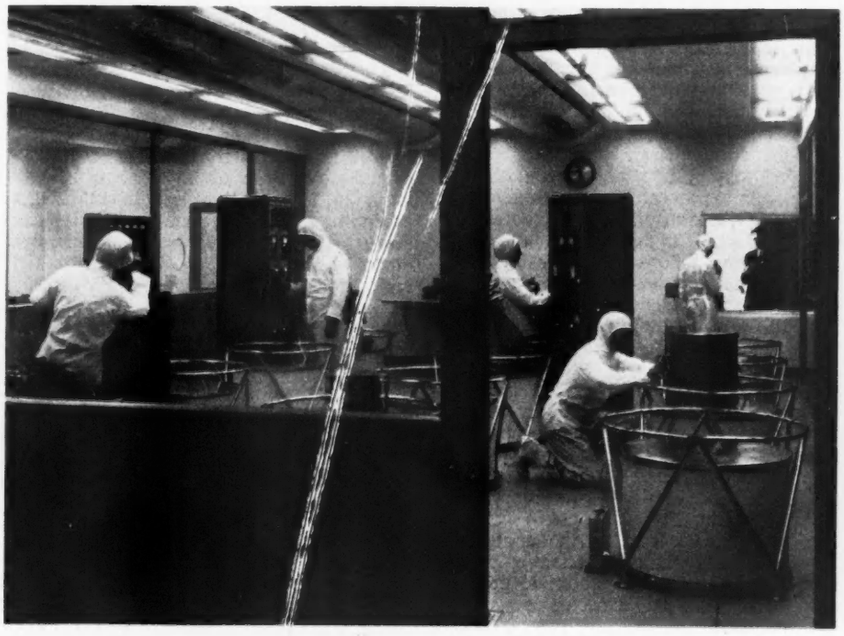
An endless rubber belt runs over two rollers. One roller is made of acrylic resin and covered with fabric and is situated in the top sphere, and the other roller, also made of acrylic resin, but coated with varnish, is situated in the base of the instrument. The lower roller is driven by the motor.

Demonstration of Van de Graaff electrostatic generator. The girl is standing on an insulated stool and is at a potential of about 500,000V

One collector is fixed close to the top roller and is connected electrically to the inside surface of the top sphere. A second similar collector is placed close to the bottom roller and is connected electrically to an insulated terminal, which, in turn, is earthed. The whole base of the instrument should be earthed.

When the belt travels over the rollers the top sphere becomes progressively positively charged. The maximum voltage obtainable is limited by the diameter of the sphere, the efficiency of the insulation of the materials used, and by the humidity of the air.

The total height of the generator is approximately 100cm. The motor which drives the belt is for direct connection to a mains supply of 200V to 250V a.c. or d.c., and is enclosed in the base of the instrument. The base also incorporates a variable speed control in the form of a rheostat in series with the motor. This is operated by an external knob which can be rotated to adjust the speed of the belt, and thus the charging rate.



Test area of new laboratory for production of components for inertial navigation systems

Radio Telephone Service for Cars

TOWARDS the end of next month the General Post Office will open the first public radio telephone service for vehicle users in this country. The new service will have two main stations, giving v.h.f. radio coverage of the southern half of Lancashire, the Wirral, and parts of North Cheshire. Customers who fit their vehicles with suitable radio equipment and are within range of either station will be able to make calls to, and receive them from, any telephone in the United Kingdom and the Irish Republic.

This will be an experiment in extending the telephone service to vehicles, and the Post Office states that if the scheme is a success it will doubtless be extended to London and other centres. The charges will be 2s. 6d. for three minutes for a local call within the area of radio coverage, and 2s. radio charge plus the appropriate trunk charge for a call to or from a telephone outside the South Lancashire area. In addition, there will be a standard licence fee of £7 10s. a quarter. Special terms will be available for users making a large number of calls.

Industrial and Labour Notes

Engineering Production

According to Board of Trade statistics, production in Britain's engineering and electrical goods industries in June was 2 per cent higher than in June, 1958. That increase was smaller than in May, but it is estimated that it brought the volume of production in the second quarter of this year to 6 per cent more than in the comparable period of last year. After making allowance for the incidence of the Easter holiday in both years, the Board of Trade says it is clear that the rate of output in the first half of this year was rising, the expansion being attributed to increased production of consumer goods. The information so far available for July suggests that production was substantially higher than in July, 1958, although it was depressed by the beginning of annual holidays.

The total volume of exports of the products of the engineering and electrical goods industries, though lower than in 1957, was rising during the first half of this year. In the second quarter, engineering and electrical goods exports were 5 per cent more than a year earlier after being 7 per cent less in the first quarter. Orders on hand, mainly orders for capital goods and components, both for the home and export markets, ceased declining in March and have not changed very much since then. The index numbers for the second quarter of this year (1954=100) were : mechanical and electrical engineering production, 116 ; exports, 116 ; orders on hand (January, 1958=100), 86. It should be borne in mind, however, that these indices do not include shipbuilding and marine engineering, vehicles and " miscellaneous metal goods."

Distribution of Industry

Some comments on the movement of industrial establishments were made by the President of the Board of Trade, Sir David Eccles, during a visit to the Scottish Industries Exhibition on Thursday of last week. He said that the next Government would need new and flexible powers to deal with local unemployment that could arise either from swift changes in techniques and markets or from the commercial handicaps inevitable in certain areas of the United Kingdom. It would be foolish, Sir David added, to support a policy based wholly on either taking workers to places where work was available or on bringing work to the workers who were unemployed. Both policies were needed, he claimed, in a scientific age when adaptability of all kinds was an essential ingredient for keeping in the front rank of industrial economics.

Sir David went on to say that firms which had established themselves in unemployment areas had sometimes taken the plunge with reluctance and doubt. But in almost all cases they had found new strength in their new surroundings, had brought notable social gains to particular localities, and had been able to operate their new plants efficiently and economically. But, Sir David continued, the present powers to persuade industry to move had proved to have certain weaknesses. First, the present Acts of Parliament only gave the Government powers to build factories in the old Development Areas, the factories being leased on rentals based at current market values. Many of the firms which were expanding preferred to design and own their factories and did not want, and, indeed, should not be asked, to go to a trading estate. Secondly, Sir David remarked, the practice had grown up of regarding the Government as a " lender of last resort." In other words, if a firm was credit-worthy and could raise capital through commercial channels, the Government had been unable to offer loans. Sir David said the Government believed some major changes should now be made. First, grants should be available to those who preferred to build their own factories ; those grants being related to the difference between the construction cost and the value on the open market of the factories when built. Secondly, as to the condition for receiving loans towards plant and equipment, that the firm should show it could not raise the money from commercial sources had proved a serious handicap which ought to be discarded. It would be wise, also, Sir David observed, to ask for power to add to the list of places which qualified for help, places where there was a clear and imminent threat of high unemployment. The Ministry of Labour and the Board of Trade would know in advance when a coal pit was going to be closed and would lose no time in looking for and persuading a new industry to come in where no alternative employment appeared likely to be available.

Modern Apprentices

Among the many conferences organised annually by the Industrial Welfare Society is one for apprentices. This year's apprentice conference was held recently at Oxford. During this conference a survey was conducted among the 400 apprentices who attended, each of them being invited to complete, anonymously, a questionnaire. The information derived from this survey is interesting.

The survey revealed that the present-day trade apprentice is generally between seventeen and a half and twenty-two years old ; none of those questioned considered that they belonged to the " upper class," only 25 per cent claimed that they came from the working class, 60 per cent believed that they were in the middle or lower middle classes, and 15 per cent, the Industrial Welfare Society says, asserted that they did not believe in class at all. The apprentices' fathers, the survey showed, followed a variety of occupations from senior managers to labourers and from ministers of religion to turf accountants. The fathers of only 20 per cent of the boys were skilled industrial craftsmen. Other interesting points brought out by this survey were that 40 per cent went to grammar schools, 30 per cent to secondary modern schools, and a little more than 20 per cent to secondary technical schools ; 30 per cent of the boys expected to be promoted to supervisors, but only just over 10 per cent anticipated that they would rise to executive level, and 50 per cent of the apprentices expected to stay with their present employers at the end of their time, about 15 per cent more saying that they expected to stay " at least a while."

The Industrial Welfare Society has added a comment that in one matter apprentices have not changed with the times. Spelling throughout the completed questionnaires was atrocious !

Suggestion Schemes

The value to be derived from well-organised works suggestion schemes was emphasised by Mr. P. Clavell Blount, in addressing the Barrow Local Productivity Association last Friday. He said that if top management was enthusiastic about suggestion schemes, a forward looking policy would be developed leading to the proper administration and promotion of such schemes. But if top management was not enthusiastic, it was most unlikely that anyone at a lower level would have much confidence in a scheme.

It was the deliberate, organised encouragement of useful thinking that was so badly needed in this country to-day, Mr. Blount continued, and it was sheer nonsense for anyone in authority to say that " if a man has a good idea, he's only got to come forward and tell us about it." The fact was that it was most rare for the man in a humble position who had a good idea to come forward with it without any encouragement by management. Experienced suggestion scheme administrators knew very well that the man with latent creative talent must, in ninety-nine cases out of a hundred, be wooed and coaxed with patience and understanding. and constantly encouraged to use his talent on his firm's behalf. But as one worker ventured a suggestion and collected an award, so were others stimulated to try for themselves. In this way, Mr. Blount suggested, an atmosphere was developed in which men and women in the rank and file took pride in being co-operative and alert for improvements.

Capital Expenditure

The Board of Trade says that estimates which have been made from forecasts supplied by a sample of companies during recent weeks indicate that fixed capital expenditure by private industry as a whole may be slightly greater during 1959 than had been estimated at the beginning of the year. Companies' forecasts made at the end of 1958 and the beginning of this year had indicated that manufacturing industry's capital expenditure would be about a tenth lower in 1959 than it was in 1958, with expenditure on plant, machinery and vehicles down by about a tenth and building work down by about a sixth. Revised estimates indicate no significant change in this earlier assessment. But preliminary forecasts of expenditure during 1960 which have been made by manufacturing companies, show that their expenditure next year may be 5 per cent lower than in 1959, with expenditure on plant, machinery and vehicles again lower by about a tenth, but with expenditure on building work slightly higher than in 1959. Provisional estimates show that, during the second quarter of this year, fixed capital expenditure by manufacturing industry was 10 per cent lower than in the second quarter of 1958. Total capital expenditure by " other industries and services " in the second quarter of this year was about 14 per cent higher than a year earlier. The increase is attributed mainly to bigger spending on new building work.

International Motor Show at Frankfurt

No. II—(*Continued from page* 279, *September* 18)

IN our last issue we discussed the economical position of the German motor industry and its influence on world markets, and gave a short survey of the principal trends of Continental automobile engineering as reflected at the Frankfurt show. We now turn to a more detailed description of the latest German models and some of the foreign cars which are making their first public appearance there.

Motor-Cars

Daimler-Benz A.G., Germany's oldest and best-known automobile factory presents a complete range of its large manufacturing programme of Mercedes cars, commercial vehicles and diesel engines. The four-cylinder models " 180 " and " 190 " and the models " 180 D " and " 190 D "—the latter basically similar to the former, but fitted with diesel engines—remain basically unchanged apart from modifications in body styling; lower and wider radiator grilles, strengthened bumpers and combined tail lights give the cars a new, modernised note without impairing the traditional Mercedes character. The output of the 1·9-litre four-cylinder short-stroke engines has been further increased, that of the model " 180 " to 78 h.p. at 4500 r.p.m. (at the low compression ratio of 7 : 1), and that of the model " 190 " to 90 h.p. at 5000 r.p.m. at a compression ratio of 8·8 : 1. The output of the diesel engines of the two models " 180 D " and " 190 D " remains unchanged at 46 h.p. and 55 h.p. respectively. Improvements in equipment comprise a new steering wheel with a large padding of the recessed hub, padded instrument panels and sun visors, resilient control buttons and a re-designed heating and ventilating system.

The six-cylinder range of Mercedes cars (Fig. 1) has been drastically re-designed, the new models being longer (in spite of a shorter wheelbase), lower and wider than their predecessors; they have a considerably larger window area and a bigger luggage boot. Trim and equipment are in accordance with the standards accepted for cars of this class and reputation, and it is claimed that in such aspects as appearance and performance, they are better still than their predecessors. They have an overall length of 16ft with a wheelbase of 12ft, a mean track of 4ft 10in and a kerb weight of about 26 cwt.

Fig. 1—Mercedes-Benz 2·2-litre saloon

The three models, all fitted with six-cylinder 2·2-litre engines of 80mm bore and 73mm stroke, have the designation of " 220 " (instead of the former " 219 "), " 220 S," and " 220 SE." They all have the same wheelbase and the same new body with identical inner and outer dimensions; the engines also are basically similar, but of different output. The " 220 " with two single-choke down-draught carburetters develops 105 h.p. at 5000 r.p.m., the type " 220 S " with two twin-choke carburretters 124 h.p. at 5200 r.p.m., and the " 220 SE," fitted with Bosch fuel-injection (described in THE ENGINEER of November 7, 1958) gives about the same power, but with a peak of 134 h.p. in the range between 5000 and 6000 r.p.m. The output of these engines is higher than that of last year's models by reason of detail improvements in the valve operating gear which comprises rockers pivoting on individual ball-and-socket joints instead of the formerly used common rocker shaft. Other basic features, such as the aluminium cylinder head and the oil-to-water heat exchanger, have been maintained.

There are some modifications in the design of the front and rear suspensions. At the front, the sub-frame (Fig. 2) is attached to the frame-floor body unit by rubber cushions, short trailing leaf springs transmitting the brake reactions and lateral forces, airising from cornering, directly to the body. An anti-roll torsional stabiliser is fitted between the latter and the flexibly mounted sub-frame, and the long telescopic dampers are now interposed at far-outward points between the lower wishbones and the body.

At the rear, the single-joint low-pivot axle (Fig. 3) carried by coil springs and located by lateral trailing arms, now has an additional compensating spring as on the roadster " 300 SL." This spring, interposed between the swinging members of the divided axle, is mounted on top of the final-drive casing and has the double purpose of providing a variable spring rate as well as serving as a stabiliser.

The steering gear is of the re-circulating ball-type with automatic adjustment and a hydraulic damper attached to the three-piece track rod. The front brakes, with two leading shoes, have ventilated light-metal drums with cast-iron liners, the rear brakes with one leading and one trailing shoe are of cast iron. They are actuated by oil pressure and, in the case of the models " 220 S " and " 220 SE," assisted by vacuum servo-action. All Mercedes six-cylinder models can be fitted with the Daimler-Benz " Hydrac " semi-automatic transmission, described in THE ENGINEER of September 27, 1957.

The name of Mercedes-Benz is so closely linked with their reputation as makers of large, high-priced luxury and high-performance cars, that it is almost forgotten that the firm once, in 1933, made the attempt to enter the field of small motor-cars with a technically very interesting 1·3-litre rear-engine car, a venture which was later abandoned for purely economic reasons. It is interesting to note that Daimler-Benz A.G. has recently acquired the majority holding of the shares of Auto-Union G.m.b.H., well known as manufacturers of two-stroke engines, probably with the aim of offering a greater diversity of products to be distributed and serviced by their own sales organisation. Although Auto-Union is going to carry on as an independent company, it can be expected that some exchange of technical experience and, later on, probably some co-ordination in design will take place between the two firms. Whether or not Mercedes practice will eventually lead to the replacement of the traditional Auto-Union

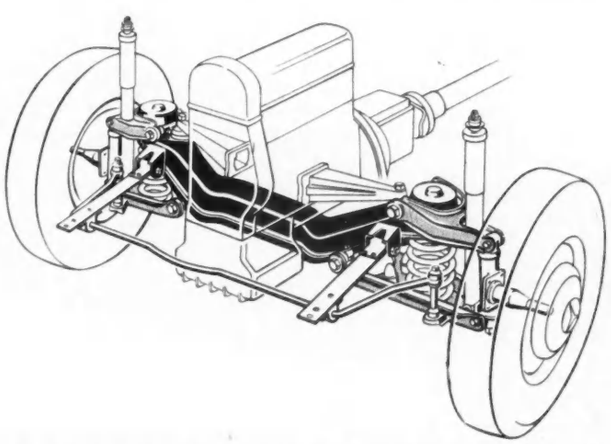


Fig. 2—New subframe supported toward the front by leaf spring struts. Independent front suspension with coil springs, dampers and torsion bar stabiliser

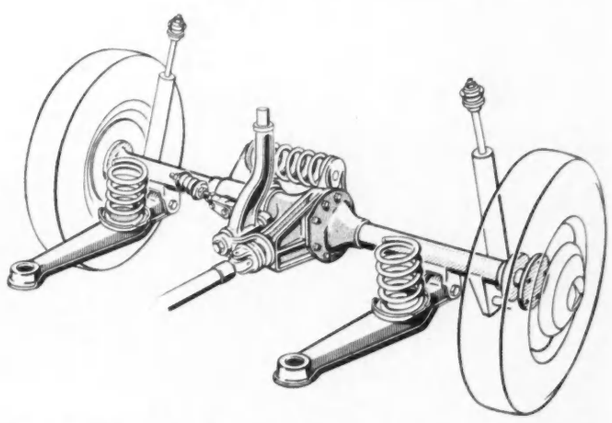


Fig. 3—Single joint swing axle with the compensating spring (above the axle drive) and thrust arms

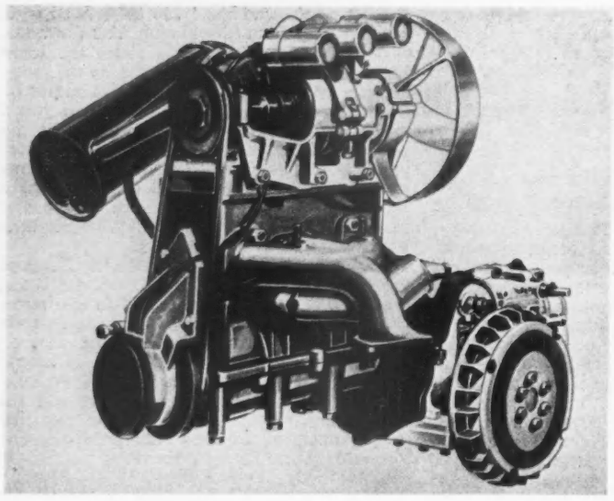


Fig. 4—Auto Union "Junior" 750 c.c. water-cooled, three-cylinder two-stroke engine

two-stroke engine by the more efficient four-stroke engine is a matter of conjecture. At present there is no indication yet that such a step is anticipated, the more as the popularity of the Auto-Union front wheel drive car is to a great extent based on the loyalty of hundreds of thousands of two-stroke enthusiasts.

Last year Auto-Union produced about 63,000 vehicles, the majority 1-litre private and dual-purpose cars, and a considerable number of light delivery vans, miniature buses, and all-wheel-drive cross-country vehicles for the fighting forces. This year public attention at the Auto-Union stand seems to concentrate upon the "Junior," a new front-wheel-drive model powered by a 741 c.c three-cylinder water-cooled two-stroke engine of 68mm bore and 68mm stroke which, at a compression ratio of 8·2 : 1, develops 34 h.p. at 4300 r.p.m. (Fig. 4). The design of the engine follows orthodox Auto-Union practice, employing the three-port system, crankcase compression and "petroil" lubrication. The built-up crankshaft is carried in four ball bearings, and rollers are employed for the big ends.

The engine, according to the now general practice in front-wheel-drive cars, is mounted ahead of the front wheel centres and the four-speed gearbox at the rear of the latter. The torque is transmitted from the clutch to the lay-shaft of the gearbox and is returned via the main-shaft to the spiral-bevel, final-drive gear ; splined half shafts with Hooke's joints in-board and constant-velocity joints at the other ends, lead from the differential to the road wheels. The amply finned drums of the front brakes are located in-board on either side of the final-drive casing. The steering layout is of the orthodox rack-and-pinion type.

The steel body of the two-door saloon is bolted to a rigid frame, built up of box-shaped, longitudinal members and tubular cross members, and strengthened by a stiff floor pressing. The suspension differs from that used for the 1-litre cars ; the transverse leaf springs at front and rear have been replaced by springs of less internal friction. Double triangular wishbones of unequal length are employed at the front in conjunction with longitudinal torsion bars, which are attached to the lower wishbones and anchored in brackets carried by the centre cross member. At the rear, a longitudinally slotted axle tube, connecting the rear wheels, is carried by two blade-shaped lateral radius arms, which are attached to square, laminated torsion bars ; the latter are housed inside the rear tubular cross member and anchored in the middle of the tube. A Panhard rod, interposed between the axle tube and the rear cross member, takes care of the lateral location of the axle.

The "Junior" (Fig. 5) is an attractive two-door saloon having modern flowing lines, a wide curved windscreen and similar rear window, a particularly well arranged instrument board, and comfortable seating accommodation. It carries four adults in adequate comfort with ample space for luggage, and is claimed to have a maximum speed of slightly less than 70 m.p.h. The overall length of the new model is 12ft 11in with a wheelbase of 7ft 1½in, a mean track of 3ft 11in, and its kerb weight is about 14 cwt.

Another entirely new front-wheel-drive car is the 0·9-litre "Arabella," made by Lloyd Motoren-Werke G.m.b.H., a firm which, like the Goliath Works, is associated with the Carl Borgward Motoren-Werke, known as the makers of the 1·5-litre "Isabella" cars. The "Arabella" has certain design features in common with the 1·1-litre Goliath "Hansa 1100" (described in THE ENGINEER of September 27, 1957) ; for instance, the front-wheel drive, the horizontally opposed, water-cooled four-stroke, engine, and the basic layout of the central backbone frame structure. In every other respect, however, it differs from the "Hansa" design, particularly in regard to the front and rear suspension.

The transmission unit of the "Arabella" corresponds to the constructional principles, now almost standard in European front-wheel-drive cars, i.e. the longitudinally mounted engine is arranged in front, and the four-speed, all-synchronised gearbox aft of the rear wheels, driving the latter via the final-drive, spiral-bevel gear by universally jointed half shafts. The 891 c.c. water-cooled, horizontally opposed, four-cylinder, four-stroke engine of 69mm bore and 60mm stroke, develops 38 h.p. at 4800 r.p.m., and has a compression ratio of 7·5 : 1. The cylinder block and crankcase is a two-piece aluminium casting, split in the vertical plane, and is fitted with detachable cast iron cylinder liners. Two through-bolts at each of the three main bearing housings and a further fourteen bolts spaced round the periphery of the joint faces, take up the gas pressures. The cylinder head is also made of aluminium and has cast iron valve seats, the valves being operated by pushrods and rockers from the camshaft located vertically above the crankshaft. The latter is carried in three indium-flashed aluminium bearings, while steel-backed lead-bronze is used for the big ends. The engine is light, compact and easily accessible ; being considerably shorter than an orthodox in-line four-cylinder unit, it is ideally suited for a small front-wheel-drive car.

The frame of the new Lloyd model comprises a central, large-diameter tubular backbone, which, at the front as well as at the rear, terminates in a fork pattern to carry the attachment points for the suspension ; box-section cross members and a corrugated floor pressing give the frame structure a high degree of torsional stiffness.

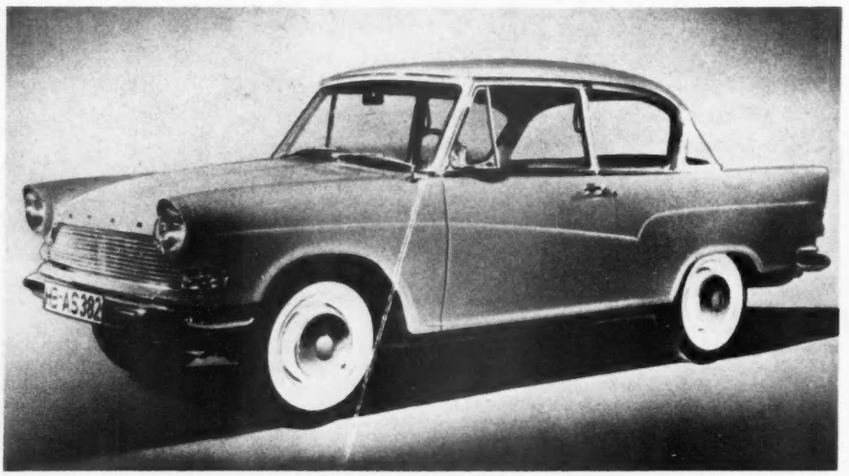


Fig. 6—Lloyd "Arabella" two-door saloon

Fig. 5—Auto Union "Junior" saloon

The front suspension is of orthodox design, employing double wishbones of unequal length in connection with coil springs and concentric telescopic dampers. The front wheels, having constant velocity joints, pivot about ball-and-socket joints, arranged in the outer wishbone ends. Steering is by rack and pinion, the rack being connected by a link joint with the three-piece track rod. It is claimed that by reason of the carefully designed steering geometry the "Arabella" is the first front-wheel-drive car with 13in diameter wheels, which has a turning radius of less than 30ft.

Coil springs and triangular trailing arms, pivoting about fairly widely spaced attachment points, carry the independently sprung rear wheels; telescopic dampers, slightly inclined towards the rear, and an anti-roll bar, are provided. The brakes, at the front as well as at the rear, have light-metal drums with cast-in iron liners.

The "Arabella" (Fig. 6) is a roomy, two-door, four-seater saloon of modern attractive appearance. It is 12ft 6in long, has a wheelbase of 6ft 9in, a track of 3ft 11in, and a kerb weight of about 15 cwt. The maximum speed is claimed to be 75 m.p.h.

The Lloyd "Alexander" models, which are all front-wheel-drive cars, having air-cooled, four-stroke, 600 c.c., twin-cylinder engines, transversely mounted and integral with the gearbox, are now equipped with a modified rear suspension, employing parallel trailing arms in conjunction with coil springs and a stabiliser.

The third newcomer to the series of German cars, designed to compete in world markets with such powerful foreign opponents as the "Dauphine," the "Fiat 1100," and the British Ford models "Anglia" and "Prefect," is the Opel "1200." In contrast with the Auto-Union "Junior" and the Lloyd "Arabella," the specifications of which had been announced some weeks earlier, the new Opel was not publicly shown until the opening day of the Frankfurt show.

Rumours had been going on for some time that the Adam Opel A.G. intended the marketing of an entirely new car, and there was a great deal of speculation whether this model would be a small car of "revolutionary" design or (as sceptics predicted) a conventional medium-sized car, probably a smaller version of the current Opel models. As a matter of fact, the new Opel "1200" conforms very closely to the latter prediction, in so far as the design is based on that of the 1·5-litre Opel "Olympia," the predecessor of the current "Record" model. Justifying the decision of rejuvenating a previously discontinued type, the firm declares that intensive market research had shown that the post-war idea of a small and austere car, merely designed as a means of transportation, had lost favour. Customers nowadays expected not only space for four or even five passengers, but also a good performance, an attractive appearance, and—last but, not least—economy in running costs. As road tax and liability insurance in many countries were based on the cylinder volume, the use of a small but sufficiently powerful engine seemed indicated. In these circumstances, the combination of a roomy, suitably restyled body and of well-tried mechanical components, together with a modern 1·2-litre high-performance engine, should produce a reliable and economical vehicle of moderate cost.

The all-steel body of integral construction has the same inner and outer dimensions as that of the 1·5-litre 1955 model "Olympia," but the appearance as well as the functional value have been improved by a wide panoramic windscreen and a large rear window. The attractive-looking two-door saloon has an overall length of 15ft 5in, a wheelbase of 8ft 4in, and a mean track of 4ft 1½in. With these dimensions and a kerb weight of close to 18½ cwt. the Opel "1200" actually belongs to the group of middle-sized family saloons, powered by an engine which, according to modern standards, is rather on the smallish side. However, it is stated that the car, having a power-to-weight ratio of 43 h.p. per ton of unladen weight (compared to about 50 h.p. per ton of contemporary cars), is quite satisfactory in regard to acceleration, climbing capacity and general performance. A maximum speed of about 70 m.p.h. is claimed.

Fig. 8—B.M.W. coupé with rear-mounted, air-cooled twin-cylinder engine

The four-cylinder o.h.v., 1·2 litre engine of 74mm bore and 72mm stroke has a compression ratio of 7·5 : 1, and develops 40 h.p. at 4400 r.p.m. (the same output as the 1·5-litre engine of the 1955 "Olympia" model). The mechanical units, such as the all-synchronised three-speed gearbox, the recirculating steering, the brakes, and the front suspension, are in accordance with orthodox Opel practice; another feature of the rear suspension is the use of tension-stressed shackles at the rear ends of the half-elliptic three-leaf springs, for the purpose of providing a progressive spring rate.

Apart from the new 1·2-litre model which, from the viewpoint of Continental designers, presents no startling innovations with regard to the general layout or to detail design, the other series of four and six-cylinder Opel cars have undergone only small alterations, mainly confined to improvements in body styling. The four-cylinder "Olympia-Record" is now available as a four-door saloon (a concession to some overseas markets) and optionally, with a 1·7-litre engine, the increase in cylinder capacity being effected by enlarging the bore of the original 1·5-litre engine from 80mm to 85mm, while maintaining the stroke of 74mm. The new engine, having a higher compression ratio of 7·25 : 1, develops 55 h.p. at 4000 r.p.m., compared to 45 h.p. at 3900 r.p.m. of the 1·5-litre unit.

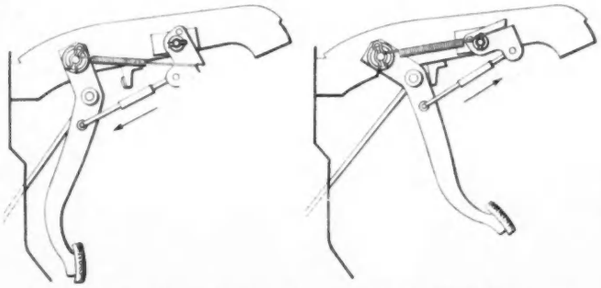


Fig. 7—Servo-spring mechanism of clutch pedal of the 1960 "Kapitan"

The six-cylinder model "Kapitan," also, has a bigger engine of 2·6-litres capacity (formerly 2·5 litres), with the same bore of 85mm as the four-cylinder, but with a longer stroke of 76·5mm; the new engine has a compression ratio of 7·8 : 1, and develops 90 h.p. at 4300 r.p.m. The wheels of the 1960 "Kapitan" have been increased in diameter from 13in to 14in, with a corresponding increase of the brake drums. An interesting innovation is the servo-spring mechanism of the clutch pedal which reduces the foot pressure previously required by a third (Fig. 7). The initial depression of the clutch pedal moves a bell-crank lever, by means of a pull-rod, into a position in which it tensions a coil spring. In this position the spring exerts a pull on the upper extension of the pendant pedal lever, thus supplementing the foot pressure and reducing the clutch effort during the disengagement.

The Opel works, being the largest European motor factory of General Motors Corporation, last year produced almost 300,000 motor-cars; they make more six-cylinder cars than any other factory on the Continent and export about 68 per cent of them, mainly overseas.

The production of Ford-Werke A.G., of Cologne, the other American-controlled factory in Germany, is considerably smaller than that of Opel, amounting in 1958 to about 116,000 motor-cars. Here, again, as in the case of Opel, the 1960 models vary from their predecessors in minor details only. The output of the 1·2-litre side-valve, four-cylinder engine (similar to that of the current models of the British Ford "Prefect") of the "Taunus 12 M" has been raised to 38 h.p. at 4250 r.p.m. by increasing the compression ratio from 6·8 : 1 to 7·4 : 1. The springing and the road holding of the car has been improved by longer and softer springs at the rear and by a stabiliser in front; a new radiator grille, a flatter roof, and better arranged rear lamps give the car a more pleasing appearance. The "Taunus 15 M," almost identical with the "12 M," but fitted with an o.h.v. engine of 1·5-litre capacity, will shortly be marketed in U.S.A. by the sales organisation of the American parent company.

The 1·7-litre, four-cylinder model, "Taunus 17 M," first introduced at the 1957 Frankfurt show, remains unaltered apart from styling modifications and some detail improvements in the induction system of the engine.

Reference has been made to the fact that the manufacturers of cars of the 300 c.c.–600 c.c. class have recently met with growing sales resistance, especially in the case of cars having an unorthodox appearance. Most of these firms are now offering new models to satisfy the demand of the more discerning customers for greater comfort, better styling and improved performance. It is obvious that such demands, which can only be met by some appropriate increase of the total vehicle weight, necessitate a raising of the engine output by such means as increasing the compression ratio, the engine speed and—last, but not least—the cylinder capacity. As a rule all of these means are being utilised, with the result that most of the former "baby-cars" have grown up in size as well as in engine capacity. The power of modern 700 c.c. air-cooled twin-cylinder power units now approaches something between 25 h.p. and 36 h.p., an output that was formerly associated with water-cooled

1-litre engines.

At the stand of Bayerische Motorenwerke A.G. public interest is centred on the new rear-engined B.M.W. cars type "700," a two-seater coupé (Fig. 8) with two auxiliary seats, and a four to five seater saloon. The new models, beautifully styled, comfortable and well equipped, are likely to replace the model "600," characterised by its unorthodox appearance with the door facing forward like that of the well-known 300 c.c. "Isetta." The basic dimensions of the coupé and the saloon are identical, both having an overall length of 11ft 9in, a wheelbase of 7ft 1in and a track of 4ft 1½in. The kerb weight of the coupé is 12½ cwt, and the maximum speed should exceed 70 m.p.h.

The steel body is welded to a pressed floor unit, strengthened by box-section longitudinal members and a tunnel. The 700 c.c. air-cooled, horizontally-opposed, twin-cylinder engine of 78mm bore and 73mm stroke with a compression ratio of 7·5 : 1, develops 30 h.p. at 5000 r.p.m., compared to 20 h.p. of the 600 c.c. engine of the type "600." The layout of the transmission unit follows the pattern now standard in Continental rear-engined cars, i.e., the engine is mounted aft, and the all-synchronised four-speed gearbox in front of the rear wheel centres, the final-drive casing being located between the clutch bell housing and the gearbox (Fig. 9). The torque is transmitted from the differential to the independently sprung road wheels by half-shafts, each of which is fitted with a large flexible rubber joint at either end, to take angular as well as longitudinal deflections.

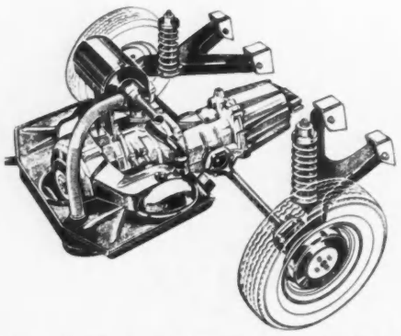


Fig. 9—Engine transmission unit and rear suspension of the B.M.W. "700"

The rear suspension employs two forked lateral trailing arms, carried in widely spaced rubber bushes, in conjunction with very long coil springs and concentric telescopic dampers. At the front the wheels are carried on each side by a pair of lateral leading arms, mounted parallel to each other in rubber bushes, and by coil springs, housing the telescopic dampers; the steering is by rack-and-pinion.

At the stand of B.M.W. are also several models of the "Vee-8" cylinder cars, basically unchanged from those seen at the 1957 show; one of these models, the 3·2-litre "Super" sports car, is fitted with Dunlop disc brakes, thus being the first German quantity produced motor-car equipped with this device.

(*To be continued*)

European Machine Tool Exhibition

No. II—(*Continued from page* 278, *September* 18)

THE six-spindle "Gyromatic" vertical, automatic machines made by the Tavannes Machine Company S.A., of Tavannes, Switzerland, are now fitted with equipment for the automatic, continuous removal of swarf by a conveyor. This development has removed the need for emptying three swarf bins, which had previously to be done at frequent intervals when a machine was used for removing large quantities of metal at high speeds.

One of the machines exhibited on second operation duties in the production of a textile spindle housing was equipped with an automatic loading device which is adaptable for hand charging or linking up with a transfer line. The device consists of an endless chain carried between indexing sprockets timed with the machining operations. The chain links form work containers and each container in turn is presented to a feeding device, which automatically transfers the components to the machine chucks on each indexing. Sufficient components are held in the loader chain to feed the machine for one hour's operation. A mechanical closing device actuates the machine chucks which can compensate for dimensional differences up to ⅛in on the parts as well as small irregularities in shape. Tavannes machines are handled in this country by Stanley Howard, Ltd., 73, Devon Street, Birmingham, 7.

A machine tool control system which is of particular interest to the firm concerned with small batch production and is relatively cheap to install on a machine has been developed by E.M.I. Electronics, Ltd., Hayes, Middlesex. To demonstrate this new equipment it is fitted on the Grimston drilling machine shown in Fig. 8. The system is fitted to a specially designed co-ordinate table having an area of 16in by 12in and which moves on recirculating ball slides. Its x and y controlled axes are 10in by 10in and the table is moved by hydraulic cylinders for which the high-pressure oil supply is derived from a normal shop supply of compressed air.

This control system employs the basic principles of the maker's other "Emicon" electronic positioning control systems, the fine measuring element being the general-purpose inductor having an electrical accuracy of ±0·0005in. It is claimed that in service the electrical positional accuracy of the table is ±0·002in and a repeatable accuracy of ±0·00in.

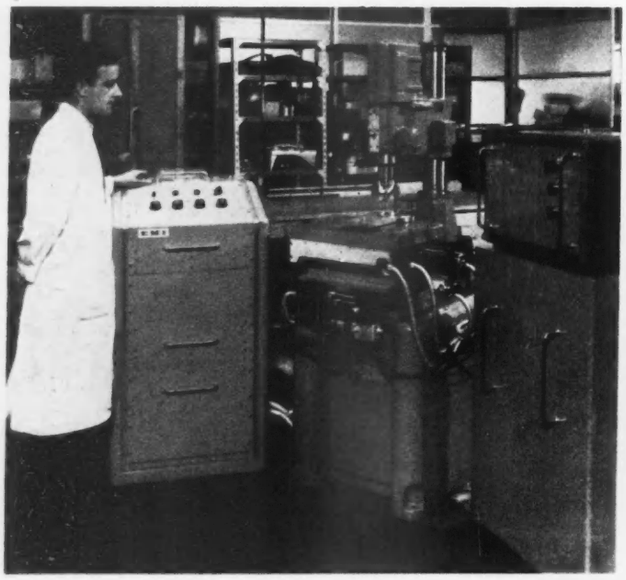
The control system and co-ordinate table are arranged as an integrated equipment which may be applied to a drilling machine of suitable dimensions and spindle quality as illustrated. The table is automatically locked as soon as the working position is reached and a signal is provided to actuate the spindle feed when the table is in place. The machine is thus arranged to proceed automatically through a complete drilling programme.

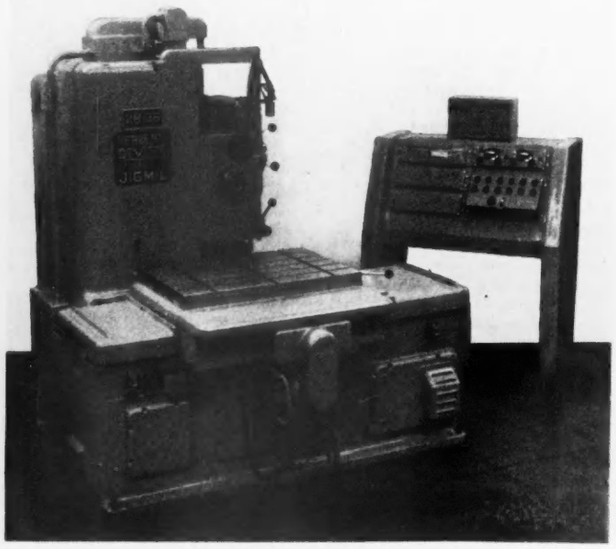
Information can be fed into the control system in the form of five-hole teleprinter tape, or, alternatively, may be set up on dials for manual operation. For tape control, ordinates of x and y are read alternately from the tape using a tape reader, the output of which operates the store unit to set up the desired position analogue voltages, the machine controls, and the automatic cycling facility.

In the sequence of operations the x ordinate is read and the table positioned; the y ordinate is then read and the table is positioned; the drilling operation is effected and when the spindle has retracted the next positioning cycle is automatically initiated.

Other exhibits on the company's stand included control equipment for two and three-dimensional contour milling machines, which is now fitted to a variety of machine tools manufactured by British, American and Continental companies, and was shown in action on the stands of the Cincinnati Milling Machine Company, E. H. Jones (Machine Tools), Ltd., Wadkin, Ltd., and Newall Group Sales, Ltd.

In addition to a representative group of





Figs. 8 and 9—(Left) Drilling machine fitted with E.M.I. Electronics "Emicon" control system and co-ordinate table. (Right) "Jigmill" equipped with a dial and tape analogue control system for positioning

lathes and drilling machines there was on the stand of Alfred Herbert, Ltd., Coventry, a 2B-36 De Vlieg " Jigmill " on which the automatic positioning system using length bars has been replaced by an alternative dial and tape analogue control system called the " Datatrol." This new measuring system is fitted on the machine we illustrate in Fig. 9 and for it Ferrand " Inductosyn " scales are mounted on the bed and column of the machine. These scales of glass are 10in long and have printed on them a flat electrical winding. Fixed on the spindle head and table are 5in long sliders similar to the scales. In operation an error voltage is produced in the scales by inductive coupling and this voltage becomes zero when the slide is moved " X " distance from its datum. This distance is selected by the use of dials which give 0·0001in increments over the full range of the slides.

The error voltage is amplified by transistors and converted to a d.c. voltage which also becomes a zero, and this zero or null signal is used to initiate the standard positioning cycle of the machine. The co-ordinates of a position may be set either by dials or pre-programmed on punched paper tape. Other signals can be obtained from the tape such as the co-ordinate number, side of index table, &c. The datum of the " X " and " Y " co-ordinates may also be moved to any position within the range of the machine.

The equipment shown by the Coventry Gauge and Tool Company, Ltd., Coventry, included the firm's new " Matrix " jig grinding machine illustrated in Fig. 10. This machine has a table with an 18in by 12in working surface, having a longitudinal traverse of 12in and a transverse travel of 8in. A quill travel of 4in is available and the maximum setting distance between the bottom of the grinding wheel and the top of the table is 16in. The spindle head is carried on a power-operated vertical slide driven by an independent motor and having push-button control.

To cover a large range of work, the machine incorporates a high-frequency electrically-driven spindle with speeds variable from 10,000 to 50,000 r.p.m. An interesting feature of the spindle design is its ability to maintain a constant speed irrespective of the load on the grinding wheel and this enables a preset speed to be selected and repeated at any time. The spindle has a collet nose so that diamond impregnated stalks, or grinding spindle quills, can be used. The grinding spindle is mounted on a cross-slide, the position of which is remotely controlled through a dial which is graduated in 0·0001in divisions and enables a radial feed to be imparted to the spindle whilst grinding is taking place.

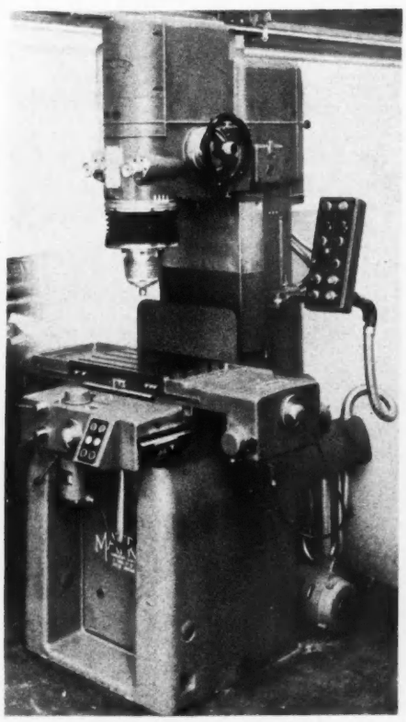


Fig. 10—" Matrix " jig grinding machine—Coventry Gauge

The spindle quill is rotated by an infinitely variable speed electric motor, providing a range of 25 to 255 r.p.m., and the 4in vertical travel is power or hand-operated to suit the work being undertaken. The power traverse speed is infinitely variable between 10½in and 105in per minute and means are provided for traversing the quill to the top of its stroke without disturbing the setting of the traverse stops for gauging and inspection purposes. Hand rotation of the quill can also be carried out for segmental grinding through a predetermined arc with reference to a graduated control dial. The quill can be inclined in its sleeve up to an angle of 1½ deg., giving accurate control for parallelism and enabling holes to be ground up to 3 deg. included taper.

The table movements, both longitudinal and transverse, are obtained by hardened thread ground lead screws and a corrector bar system ensures that precision settings are obtained. Each slide movement is separately operated by its own electric motor controlled by push-buttons on the apron, an overload clutch being fitted to prevent damage to the lead screws, whilst overrun is prevented by an automatic brake.

In setting the slides, the approximate position is obtained by power and finalised by hand with control knobs having large, clearly defined dials reading to 0·0001in direct by vernier. These dials are mounted just below the surface of each table adjacent to the hand control knobs and protected from dirt and damage by armour plate glass.

In addition to recently developed machines for straightening and polishing bright bars and centreless bar turning, a new automatic bolt blank cropping machine and automatic bolt-head forging machine were exhibited by Th. Kieserling and Albrecht of Solingen (F. W. Kubach, Ltd., 12, Sylvan Road, London, S.E.19). The bolt blank cropping machine is designed to deal with material up to 1in diameter and cut blanks up to about 12in long at speeds of eighty strokes a minute. The hot upsetting machine for forging bolt-heads blanks up to about 2¼in diameter with an 8in shank. It has a cast steel frame of closed design and a long upsetting slide has facing it a vertical indexing table with six tool stations. In the table indexing cycle there are provided two preliminary and a finish upsetting operation stations, an ejection station, a tool cooling station and a feed station. Hot blanks are fed into the machine from a drum over a chute at the lower end of which the blanks are pushed into the die. This machine makes sixty strokes a minute and its output is some 3600 bolts an hour. It is shown operating in conjunction with the bolt cropping machine and a heating furnace for the bolts.

An interesting development of Hordern, Mason and Edwards, Ltd., Kingsbury Road, Birmingham, 24, is the " Isofeed " press (Fig. 11), which is designed to reduce material and tooling costs in blanking and drawing operations when using coiled material. The machine itself is essentially an open-front, geared press of 30 tons capacity, with a 3½in stroke and a speed of fifty strokes a minute. It is capable of a maximum depth of draw of 1¼in and of handling coiled stock between 3¼in and 9½in wide. By the " Isofeed " device incorporated on the machine a " stagger " feed is imparted to the stock drawn from a bow feeding unit. The stock is positioned alternately at front and rear positions to a single tool—whereby a double row of blanks is produced from stock which is less than double the width of that from which a single row would be produced. For example, to punch round blanks 5in diameter in a row 5¼in stock material would be required. By alternately moving a wider stock strip to front and rear positions and punching the blanks in two rows a degree of " inset " can be made on the surplus material between the circumferences of the holes, and strip 9½in wide, instead of 10¼in wide, can be used, thus giving an 8 per cent saving in material.

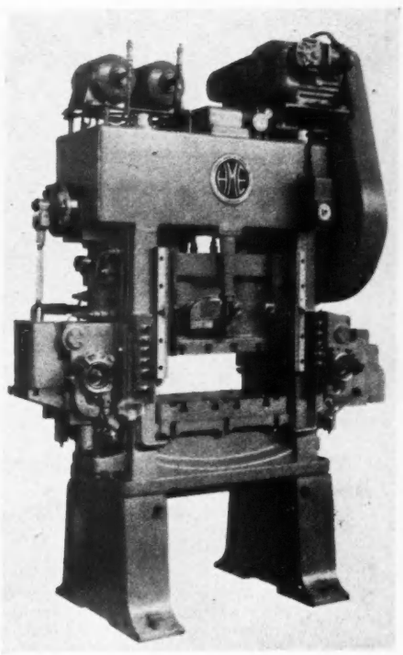
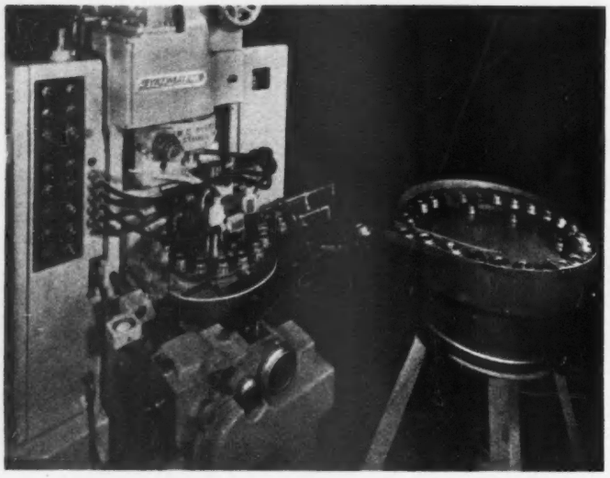


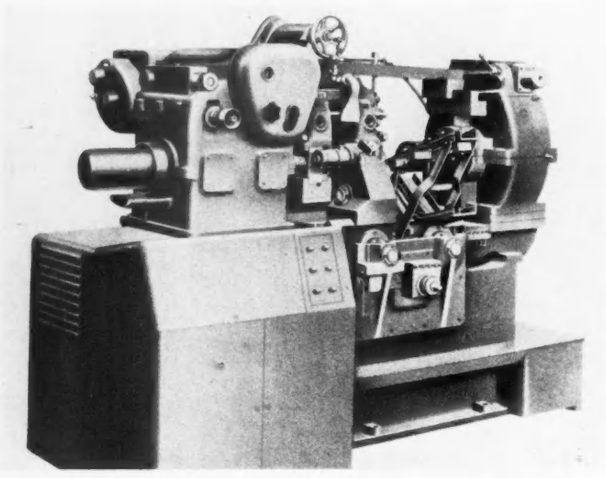
Fig. 11—30 tons capacity press incorporating the " Isofeed " stagger feed device

The machine was demonstrated using combination tools for a blanking and drawing operation, with the stock being fed from left to right. To describe its sequence it will be assumed that the cycle of operations starts with the blank to be cut in the row towards the front of the machine—that is, with the stock staggered towards the rear. Here the stock is positioned by a gauge which locates in the previously punched hole. On starting of the press as its slide reaches the bottom of its stroke the locating gauge is released momentarily by a pin in the upper tool holder and the gauge moves to the left under spring action. As the punch leaves the die the stock is released and allowed to move approximately ¼in to the right, where it is checked by an " anti-run " device. With the punch now clear, two cross slides on the " Isofeed " unit move simultaneously towards the front of the machine, taking the stock with them and, at the same time, allowing a second gauge to pass into (approximately) the centre of the hole that has just been punched. The press slide is now at top dead centre and the anti-run device is released to allow the stock to spring to the right until accurately positioned by the gauge for the next stroke of the press.

The gear cutting and finishing machines exhibited by W. E. Sykes, Ltd., of Staines, Middlesex, included one of the firm's " Sykomatic " machines, fitted with hopper feeding equipment. These machines are suitable for cutting gears with a maximum face width of 2¼in and a pitch D.P. from 6 to 6·4, the one demonstrated being tooled for cutting a two-module, twenty-six-tooth helical gear of ⅝in face width in two cuts. As can be seen in Fig. 12, this machine has a turret magazine with a number of work stations carrying the gear blanks. In addition to indexing this turret lifts vertically on a central supporting column. On the work-table of the machine is a hydraulically operated chuck above which a hydraulic tailstock is fixed.

With the turret loaded and in its upper position depression of a start button initiates the automatic cycle of operations. The turret and tailstock first move down to locate a gear on the chuck where it is clamped. The cutter and coolant motors then start and the work, together with the turret assembly, feeds rapidly to the cutting position. One, two or three cuts are made on the component as required and the final cut, at correct cutting depth, is positively located by a dead stop. After the gear has been cut the saddle retracts and the cutter motor stops, the





Figs. 12 and 13—(Left) Hopper feed gear generator with the vibratory hopper unit in position. (Right) Horizontal gear generator with magazine loading, automatic cycle and infinitely variable hydraulic infeed—Sykes

tailstock lifts, the chuck releases, and the turret rises to lift the component clear. The magazine indexes to bring the next blank into cutting position and the cycle repeats.

As each indexing movement of the turret takes place a finished gear arrives at the unloading station where it is discharged into a delivery chute; the empty station is reloaded by a hydraulic pusher mechanism attached to the hopper feed chute.

The Sykes 1A auto-loading horizontal gear generator, illustrated in Fig. 13, was demonstrated in automatic cycle operation with a magazine feed and cutting two different gears simultaneously.

The component is a four-element layshaft cluster gear, and on it two helical gears of twenty-one teeth 25 deg. H.A., and twenty-seven teeth 30 deg. H.A. are cut together; both gears being 10 c.d.p. with a $\frac{5}{8}$in face width. The material is EN 355 and the production time is four and a half minutes.

The cluster gear blanks are arranged in a magazine slide over the work spindle of the machine. These blanks are transferred in turn by a cradle to locate on a hydraulic expanding chuck and a hydraulic tailstock moves up to locate the blank.

With the blank in position the automatic cycle commences with a rapid approach to the first cutting position, at a preset point the first infeed cut commences, a second or third cut following as necessary. At the end of the cycle the saddle retracts and the blank is unloaded and discharged via the delivery chute at the front of the machine.

The rate of infeed is infinitely variable through a graduated dial incorporated in a special hydraulic control valve on the top of the machine. Depths of infeed, quick approach and drop off are individually controlled from five adjustable screws mounted at the front of the saddle. This saddle is at all times under hydraulic lock and a positive dead stop ensures the accuracy of the finished cut size.

The facility of cutting two differing gears simultaneously is given by adding a "cluster attachment" to the machine, this equipment consisting of a gear train which allows a different cutter-to-work ratio to each of the two cutter heads.

A universal trimming, rolling and forming machine for sheet metal components demonstrated on the stand of Hämmerle, Ltd., Zofingen, Switzerland (Haemmerle (London), Ltd., Livingstone House, Broadway, London, S.W.1) is designed for both automatic magazine feed or hand feeding. It is designed for high-speed operation and generally for the completion of one component in each single revolution, the main spindle speed available being up to 80 r.p.m. Each machine is supplied by the makers complete with the necessary tooling for specific classes of production, and with any required special feeding and second operation devices. When used for fully automatic cycling on work, such as beading and trimming, the machine handles components of various shapes falling within a diameter from $\frac{3}{4}$in to 9in. When under a mechanical or hydraulic control (with automatic feed if required) the machine handles irregular components within 20in diameter or circular components up to 30in diameter.

According to the duties for which it is required a machine can be provided with motor drives from 3 h.p. to 8 h.p., and a typical machine with magazine feeding gear is illustrated in Fig. 14. The two spindles for the forming or trimming rolls extending through the front of the machine column are set at $4\frac{1}{4}$in centres and mounted on needle roller bearings. The lower

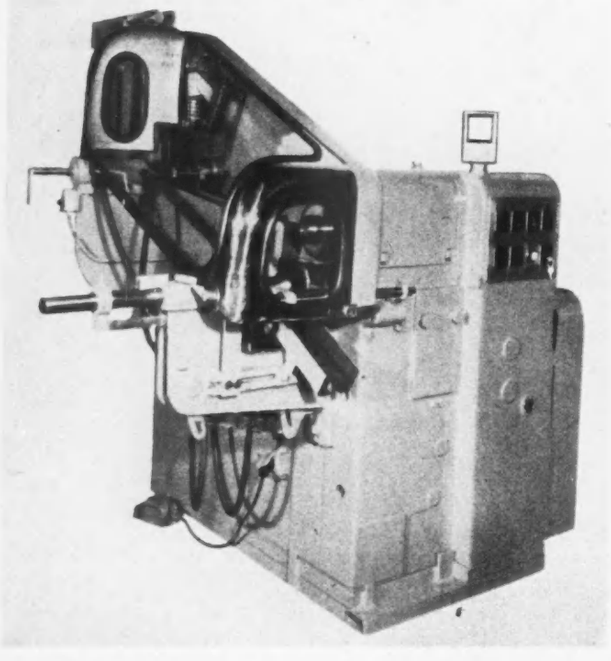


Fig. 14—Universal trimming, rolling and forming machine—Hammerle

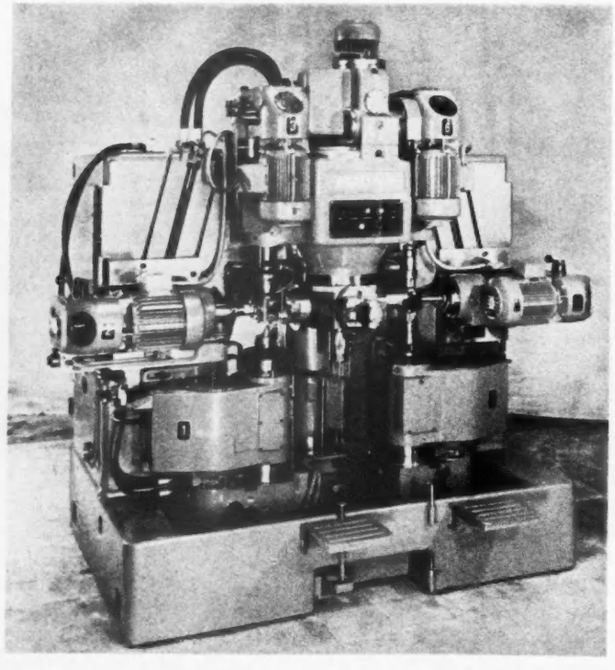


Fig. 15—Automatic multi-station machine for small components—Boehringer

spindle is driven directly from the motor through gearing giving a wide speed range and the ratio of the gears transmitting the drive to the upper spindle can be selected to give it a similar or a differential speed such as is required in trimming operations.

The upper spindle is mounted on a bracket through which the spindle centre distances are varied either mechanically from the main cam shaft of the machine or by a hydraulic unit. The cam shaft is driven with a fixed speed ratio to the lower spindle and controls the operation of the feeding, ejecting and scrap cutting devices on the machine. By combining the mechanical and hydraulic controls difficult forming operations can be carried out by moving the upper spindle down slowly in relation to the speed a forming tool is rotating. If required the spindle can be held as long as necessary in the lower, full-pressure position to impart the required shape in difficult forming operations.

It is stated that when using automatic operation with magazine feeding a machine's producf tion rate using profile cutters in trimming can be up to 4000 parts an hour ; and production rates up to 3000 per hour can be attained in component thread rolling, forming, knurling, &c.

An automatic multi-station machine suitable for the manufacture of pipe fittings, valve housings and similar components on the stand of Boehringer K.G., Goppingen, Germany (Sykes Machine Tool Company, Ltd., The Hythe, Staines, Middlesex), is shown in Fig. 15. This machine has four work-holding chucks with hydraulically-operated jaws set round an indexing central column. When a component has been loaded in the front station it is indexed successively through roughing, finishing and screwing stations at the sides and rear of the machine.

At each of the machining stations there are three sets of slide-mounted units actuated through a central electro-hydraulic system to present three tools simultaneously to the components at the three working stations. The drilling unit heads are driven by individual 4 h.p. motors through gearboxes giving six spindle speeds from 280 to 2800 r.p.m. Tne spindles have a fixed stroke of 4in and through their quills an axial adjustment of 2in. These heads are arranged for an automatic work cycle of rapid approach, feed, adjustable dwell for bottoming and rapid return. In the tapping heads drive from the 4 h.p. motors is through three step gearboxes which are available in eight ranges covering tapping speeds from 50 to 1000 r.p.m. The feed to the threading spindle in these heads is controlled by an interchangeable lead bush and nut and they have a maximum stroke of $3\frac{1}{8}$in.

A multi-station rotary transfer machine of Centec Machine Tools, Ltd., Hemel Hempstead, fitted with Maxam air-operated cylinders and valves to control and operate the sequencing and clamping systems, was demonstrated drilling a small brass component. This machine is arranged to drill automatically seven holes $\frac{1}{8}$in diameter at $\frac{3}{16}$in centre distance in the component at a production rate of seven and a half seconds. The basic unit of the machine is a 16in diameter "Centec" rotary indexing table which can be set to index any angle divisible by 3 up to 180 deg. It is claimed to have an accuracy of repetition of any position $\pm 1{\cdot}5$ seconds and an angular accuracy of ± 5 seconds of a degree. Its speed of operation is controlled by a variable orifice of a hydraulic dashpot and by pneumatic flow restriction. A specially designed rotary valve sequences the release and clamping of the components at the pneumatic fixtures.

One of the four machines exhibited by Heald Machines, Ltd., Kingsbury Road, Birmingham, 24, was a "Gage-Matic" internal grinder which has a completely automatic cycle except for loading and unloading. This machine was demonstrated rough and finish grinding a $1\frac{1}{4}$in bore, 2in long milling machine arbor collar. With the "Gage-Matic" equipment accurate sizing of the component is maintained by feeding a spring-loaded carbide tipped gauge into the rear end of the bore being ground. Directly the required size is achieved, both the gauge and the wheel are withdrawn to complete the cycle.

This firm's "Bore-Matic" boring machines were represented by a "Model 422" machine arranged as a double-ended equipment with a single boring head at each end. These machines are operated through a low-pressure hydraulic system arranged to give a variety of automatic cycles and on these boring, facing, turning, chamfering, grooving, &c., can be performed singly or in any required combination.

For demonstration purposes a cast iron component $11\frac{1}{2}$in diameter by $5\frac{1}{2}$in thick was machined. The standard right-hand head is used to bore and plunge-face counterbore a hole and the left-hand head to bore a parallel and tapered hole. This left-hand head is for this purpose fitted with a hydraulically operated feed mechanism to give a longitudinal feed motion to the tool independently of the machine table.

To show one arrangement of the Heald model "S" "Bore-Matic" an equipment of general "L" shape in plan was shown. These machines are compounded from basic units to build single-purpose machines or provide stations in multi-head transfer lines. In the machine exhibited a square centre section forms the "hinge" to which the two slide-unit arms are fastened—one at the rear and one at the right-hand face. Bases of all the three units are prefabricated steel with separate wall-mounted electrical control panel and hydraulic pump/tank/valve assembly units to facilitate ease of maintenance.

The slide units are of horizontal construction, each carrying a table sliding on hardened and ground ways. The table motions are longitudinal and are operated hydraulically through pistons and cylinders with control through trip plungers and positive stops. Feed and rapid traverse rates are available in both table directions with infinitely variable rates of feed within the range. Each slide unit supports one independently-driven, precision boring head, the rear slide unit carrying, in addition, a hydraulically operated rotating cross-feed unit over which the standard head with its straight boring tool is bridged.

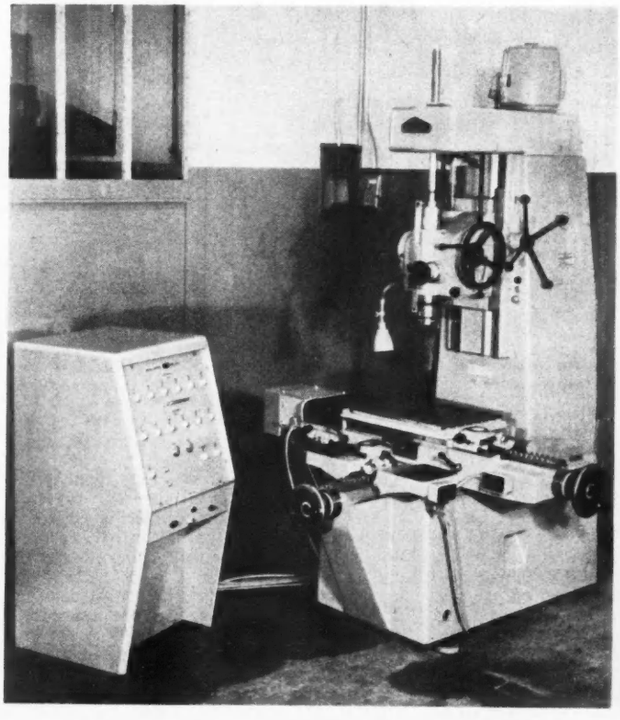


Fig. 16—"Spacematic" jig boring and milling machine—Newall

The Newall Engineering Company, Ltd., of Peterborough, showed, together with one of its crank pin grinders, the recently introduced "Spacematic" automatic-positioning jig boring and milling machine illustrated in Fig. 16. On this machine, in addition to the Newall patented roller measuring system which enables table settings direct to 0·0001in to be made, there is also a separate automatic positioning system which has been developed to give greatly improved production times when an overall accuracy of 0·0005in is adequate. This adapts the machine for producing high accuracy jigs and components, using the manual setting system, and provides automatic setting for the more numerous cases both of jigs and components where a slightly lower accuracy can be tolerated. Furthermore, it frequently happens that in one component a few holes may be closely toleranced for spacing, whereas the remainder are not so critical in this respect ; in such cases the two measuring systems, which are easily zeroised in relation to each other and the workpiece, may be used in conjunction according to requirements.

The automatic measuring and control system designed and manufactured by Airmec, Ltd., operates essentially by measuring very accurately the total angular rotation of the hardened and ground lead screws by special commuter positioning units. In order to hold the inherent accuracy of the system which fundamentally relies on lead screw precision, backlash has been eliminated by arranging that final approach to position always occurs from the same direction ; any cumulative lead screw errors are corrected by a cam in the gearbox. No valves are used, operation being achieved by employment of low voltage, direct current switching circuits based on G.P.O. type relays. A feature of the system is that the positioning unit measures absolute angles and the work table automatically positions correctly, no rezeroing being necessary after any interruption or power failure.

Range of movement of the 20in by 15in work table of the machine under automatic control is $15\frac{1}{2}$in by $10\frac{1}{2}$in, with an overall accuracy of $\pm 0{\cdot}0005$in on each slide; over shorter distances the accuracy is said to be to a higher order. Repeatability is approximately 0·00015in, and the smallest unit of input information is 0·0002in. The required table and cross-slide ordinates are selected by either two rows of six dials which are rotated by hand to the required digits ; or by a punched paper tape.

In the case of the tape each digit in the co-ordinate is represented by holes punched according to an extremely simple code by a simple keyboard punch included with the equipment. Co-ordinate information for up to 600 operations, together with such additional information as stop signals, tools to be used and automatic tape run-back is contained in a relatively short tape.

Automatic table positioning is initiated by a single push-button and commences with the unclamping of both slides ; simultaneous movement of the table and cross slide to the required co-ordinate setting ensues and this is followed by automatic clamping of the slides. On completion of the positioning cycle an electrical signal is given to indicate that machining may commence.

During the machining period, the tape moves to the succeeding information group and the programmer awaits a signal given by the operator to show that the operation is completed. On receipt of this signal the positioning cycle is recommenced.

(*To be continued*)

Conversion of Transfer Machines for Automobile Parts

THE Buhr Machine Tool Company, of Ann Arbor, Michigan, recently completed the conversion of one of its in-line "Economatic" transfer machines from making two-dimensional torque converter housing adapter plates to the production of three-dimensional torque converter housings. Because the original machine was made from standard Buhr "building-block" components, it was found easy to make this conversion. The original unit was a twenty-two-station in-line transfer machine built three years ago. The machining stations were set up to drill, bore, ream, tap and chamfer holes in the major plane of 1in thick adapter plates. Tool spindles were fed in from both sides of the part as it progressed through the machine on one edge. To simplify maintenance, all hydraulic reservoirs and pumps were situated on one side of the machine and all electrical equipment was situated on the other side. Gauging probes were used at two stations to ensure product quality and to protect subsequent tools.

When production of the original adapter plate design was ended, the machine was returned to Buhr for conversion to handle a different part. The new workpiece, a torque converter housing, was to have drilled, bored and tapped holes in the engine, transmission and dust-pan faces. Because of the depth of the workpiece, this meant machining in two parallel planes, separated by a considerable distance, and in a third plane at right angles to the other two. It was necessary to widen the workpiece area along the full length of the machine, but the original centre bases were big enough to accommodate both the wider workpiece and the new transfer-bar assembly. The new and the reworked heads are all oil-mist lubricated, and cutting fluid is provided by an overhead pipe and manifolding at each head. In the early stations of the machine, the housing is moved along on its dust-pan face while the engine and transmission face holes are put in from each side. When the holes in these faces are completed, the part enters a 90 deg. turnover fixture, where it is lowered on to the engine face. The housing proceeds through the rest of the stations on the engine face, while the dust-pan face holes are drilled and finished. As the workpiece leaves the last machining station, it enters an unloading fixture. This fixture is actually a diverter that can continue the housing on in the same direction or unload it to one side.

In much less time and with only about half of the cost of a new machine, this converted transfer line was placed in production of a more complicated part than the one it originally made. Not only does this represent an extension of the amortisation period for a large part of the first machine, but it permitted the modernising of the machine. Even though the new part is more complex than the original one, the production cycle time has been reduced from twenty-three to thirteen seconds.

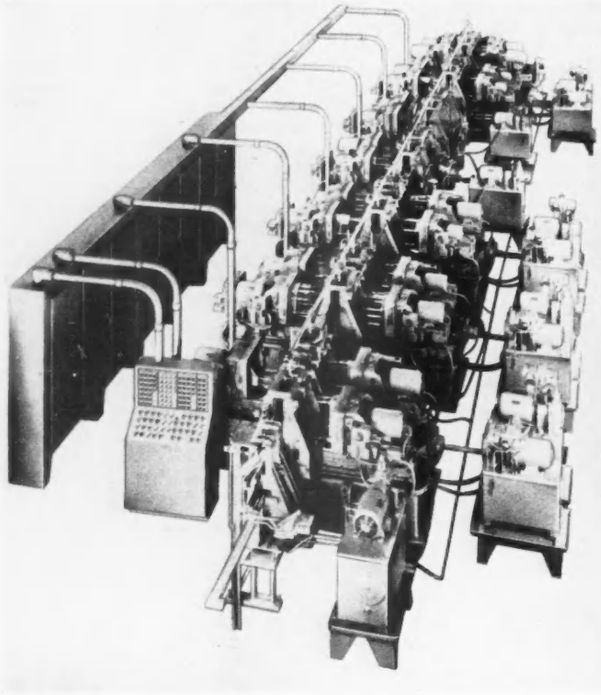


Fig. 1—Original transfer machine arranged for the machining of torque converter housing adaptor plates

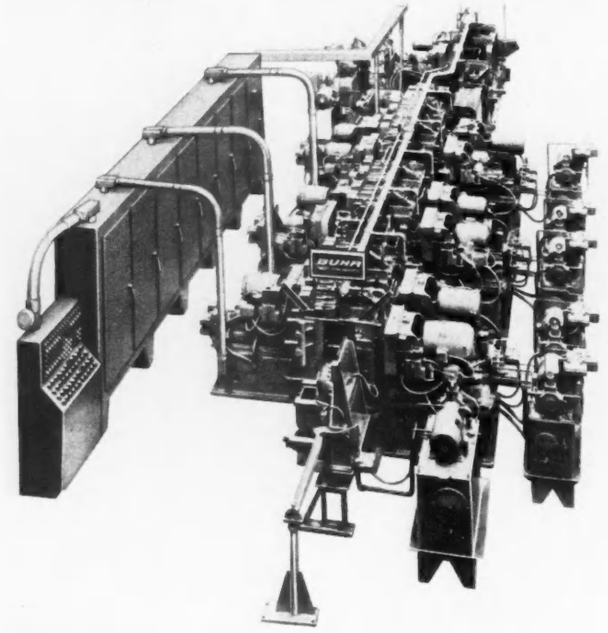


Fig. 2—Converted transfer machine set up to machine torque converter housings

Forecast of Prices of Used Commercial Aircraft

THE Transportation Centre at Northwestern University, Evanston, Illinois, has made public the remarkable results of a study of the prices of those used commercial aircraft which will be displaced as the airlines of the world make the transition to turbine-powered fleets. According to Dr. Stephen P. Sobotka, assistant director of research at the Transportation Centre and project leader of the study, the forecasts indicate: (1) The most recent model of four-engine Turbo-Compound aircraft, such as the Douglas DC-7, and the Lockheed "Super G" and the "Starliner" "Constellations" (L–1049G and L–1649), will diminish rapidly in price and will be taken out of airline service. They may be at or near scrap values as early as the end of 1959, and will almost certainly fall to that level by late 1960. The price of the Boeing "Strato-cruiser" is expected to fall to scrap value in 1959. (2) Most of the older and smaller four-engine aircraft, such as the Douglas DC–6 and the Lockheed "Constellations" and "Super Constellations" (L–049, L–749, L–1049), will probably decline in price more slowly than the Turbo-Compound engine aircraft, and are likely to maintain significant but lower than present values during 1959. By the end of 1960 or during 1961 those aircraft will be at or near their scrap values. (3) The price of the Douglas DC–6B is predicted to decline less than that of the previously mentioned aircraft, but more rapidly than that of two-engine aircraft or Vickers "Viscounts," and will fall below the prices of some of these aircraft. The DC–6B price will remain considerably greater than scrap value throughout the forecast period. Similarly, the Douglas DC–4 will remain in service and retain some value higher than scrap value until 1965, but will tend to decline gradually in price. (4) The value of the "700" series "Viscounts," the only non-piston engine aircraft for which a forecast was made, will tend to decline rather slowly throughout most of the period. (5) The post-war two-engine American aircraft, the Convairs and Martins, will be fully used and will retain relatively high, though probably slowly declining, prices throughout the forecast period. (6) The Douglas DC–3 will continue in airline service until 1965. However, as the number available will be large relative to the number in airline use, their price will be near or at scrap value throughout the period considered.

The forecasts are based on the following basic assumptions: (1) The free world air travel market will grow at fairly constant absolute increments to 108,000 million revenue passenger miles by 1965. No wars, big or small, will suddenly increase the demand for aircraft; nor will recessions in business activity decrease air travel. (2) The United States armed forces will not dispose of a large number of transport aircraft. Neither will the United States Government enter the market as a purchaser of aircraft now in airline use. (3) There exists a reasonably free world-wide market for aircraft in which airlines are able to buy and sell aircraft on the

basis of individual requirements. (4) Each airline or owner of aircraft is well informed about the status of the aircraft market at all times and acts on the basis of this information in his own best interests. (5) With the introduction of jet aircraft, passengers will not exhibit significant preferences between different types of piston aircraft. (6) The conversion of piston-powered aircraft to turbo-prop power or the conversion of passenger aircraft to cargo aircraft would not significantly change the results obtained for unconverted aircraft.

The study indicates that the financial well-being of the airlines over the next several years will be influenced by the prices which can be realised from the sale of used transports during the transition to the first full generation of turbine-powered equipment. The trunk airlines of the United States now possess flight equipment with a depreciated value of nearly 1000 million dollars. Proper planning for the timing and financing of the replacement of much of this investment can be facilitated by reliable predictions of the prices at which used commercial aircraft will tend to sell. Therefore, the findings of this study should be of interest, not only to the airlines, but also to aircraft manufacturers, to financial institutions, to dealers in aircraft and to governmental agencies.

Growth of Metal Single Crystals

In basic corrosion research at the National Bureau of Standards, Washington, D.C., metal single crystals are now being used to study the complex destructive processes of corrosion. These studies require specimens with a definite atomic arrangement, either in their surfaces or

Fig. 1—Placing of crucible assembly into single crystal growing vertical furnace developed at the N.B.S.

in certain crystallographic directions within the specimen. However, difficulty has been experienced in producing specimens having a preselected preferred orientation in combination with the desired cross-sectional shape.

A preferred crystallographic orientation can be obtained by growing crystals in a horizontal furnace, but specimens with a particular shape can be produced only in a vertical furnace. By adapting the technique employed in the horizontal furnace for use in a vertical furnace, the Bureau's corrosion laboratory has devised a means for growing crystals of the desired orientation in practically any shape. This method employs a procedure known as "seeding," which has been used to grow preferentially oriented crystals in a horizontal furnace. In this procedure, the seed—a small, single crystal of the same metal as the main crystal—is attached to the main crystal in a boat container. The crystallographic orientation of the seed, which has been ascertained by X-ray diffraction methods, is fixed parallel to the orientation desired in the main crystal. This orientation is also parallel to the direction in which the metal is moved from a molten zone to a cool zone in the horizontal furnace. Only a portion of the seed crystal is melted as the molten metal passes

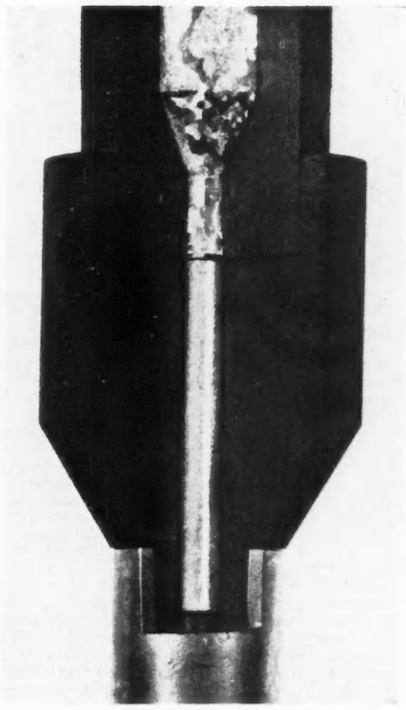


Fig. 2—Cut-away view of graphite crucible assembly, with copper pipe at the bottom and seed held against the main crystal by graphite rod

laterally through the horizontal furnace. The rate of movement is controlled to permit the molten portion of the seed to freeze in accordance with the orientation of the unmelted portion. Subsequently, as the molten mass slowly cools, the main crystal freezes in the same orientation. Efforts to produce this preferred orientation in a vertical furnace, however, have not been generally successful in the past because of the difficulty inherent in attaching and partially melting the seed in an upright position.

To overcome this difficulty, special equipment was designed. It consists of two cylindrical crucibles of graphite machined so that they can be joined together to hold the main crystal and the seed, respectively. A cooling device, comprising a copper pipe about 2½in long with a wall thickness of ⅛in, is fastened to the lower portion of the seed crucible to conduct heat away from the bottom of the seed and thus prevent this portion from melting. A graphite rod, inserted in a cavity in the lower portion of the seed crucible, holds the seed in position against the bottom of the main crystal. The assembly is lowered through the top of a vertical furnace to a position where only the upper part of the seed is melted. This position is ascertained with a thermocouple placed in the immediate vicinity of the cooling device. When the correct position has been established in a furnace of known heat content, the same percentage of seed can be melted in successive operations. It has been found that seeds melted in this manner can be used repeatedly. It has also been found that the most desirable specimens can be produced when the crucible assembly is lowered in the furnace from the molten zone to the cool zone at a speed of ½in per hour. With this procedure, the solidifying metal not only assumes the orientation of the original seed crystal, but also freezes in any desired shape.

Development of Thermal Breeder Reactors

The U.S. Atomic Energy Commission has initiated a long-range programme to develop effective thermal breeder reactors which would make full use of the latent energy in thorium. The responsibility for the programme, to be known as the Thermal Breeder Reactor Programme, has been assigned to the Commission's Oak Ridge Operations Office. Thorium is an element which, when bombarded with neutrons, is converted to fissionable uranium-233. It is more abundant in the earth than natural uranium; however, the amount of known reserves that can be exploited for commercial use is less than natural uranium. In the initial loading of the thorium-uranium cycle, thorium is inserted in a reactor fuelled with either uranium-235 or uranium-233, both fissionable materials. The chain reaction is sustained by the uranium while the thorium is converted to new uranium-233. The uranium-233 produced is then available to replace the fissionable material used during reactor operation.

The new programme has as its objective the development of a thermal breeder reactor capable of converting thorium to fissionable fuel material at a doubling time of not more than twenty-five years. The new programme also involves a re-orientation of work on the Fluid Fuel Reactor Programme previously conducted for the Commission by the Brookhaven National Laboratory and the Babcock and Wilcox Company on the Liquid Metal Fuel Reactor (L.M.F.R.) concept and by the Oak Ridge National Laboratory on the Aqueous Homogeneous Reactor (A.H.R.) and Molten Salt Reactor (M.S.R.) concepts. Much of the work on these projects has been directed toward the development of reactors of these concepts for the production of economic electric power. During the fiscal year 1960, research and development on the A.H.R., M.S.R. and L.M.F.R. concepts will be discontinued and a transition of financial support made to the new programme. The Commission's decision to re-orient the Fluid Fuel Programme towards implementation of the Thermal Breeder Reactor Programme was based on the results of a study by a special task force of scientists and engineers convened by the Commission in January, 1959, to make a comparison of the reactor concepts included in the Fluid Fuel Programme. As a result of estimates of the power costs of large-scale fluid fuel reactors and on the cost and scope of research and development compared with that of other reactor concepts in advanced stages of development, the Commission concluded that there is little incentive for further development of fluid fuel reactors as an approach to the attainment of low-cost nuclear power in the near future. Therefore, the Commission decided to re-orient its fluid fuel effort toward the use of the latent energy in thorium and natural uranium through a long-range development programme. Because all three of the fluid fuel reactor systems were found by the task force to be potentially capable of development as breeder reactors, the new Thermal Breeder Programme may include one or more of the concepts included in the Fluid Fuel Programme.

In the initial phases, the new programme will be a basic research and development effort and will include an evaluation of reactor technology to determine the most promising kind of thermal breeder reactor for continued long-range development. Any work continued on present fluid fuel reactor concepts will be conducted in the framework of the broader Thermal Breeder Programme.

Personal and Business

Appointments

MR. T. G. MUNRO has been appointed sales manager of Southern Forge, Ltd.

MR. G. E. HART has been appointed technical sales director of Chamberlain Industries, Ltd.

MR. A. I. GROUSHKO has been appointed southern area manager for Archibald Johnstone (Engineers), Ltd.

MR. J. E. CLARK, M.I.E.E., has succeeded Mr. D. C. Birkinshaw as chairman of the Television Society.

MR. DAVID WILLIAMS has been appointed deputy education and training officer to the Electricity Council.

MR. K. G. C. NICHOLLS has been appointed manager of the Walsall branch of Atlas Copco (G.B.), Ltd.

MR. R. T. KNOWLES has been appointed sales director of the new South African A.E.C. company, A.E.C. Vehicles (S.A.), Ltd.

MR. A. BLACK, sales director of Opperman Gears, Ltd., has been appointed to the board of Limi-Torque Valve Controls, Ltd.

B.H.D. ENGINEERS, Ltd., announces that Mr. P. Rushworth, Mr. A. J. M. Henshaw, and Mr. P. Croset have been elected directors.

CROFTS (ENGINEERS), Ltd., has announced the appointments of Mr. L. C. Blake and Mr. A. F. Peggs as additional representatives for the London area.

MR. STANLEY C. E. LEWIS has been appointed group supplies manager and a member of the Motor Car Body Divisional Board of the Pressed Steel Company, Ltd.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., has announced the appointment of Mr. C. F. Gimson as divisional assistant chief engineer, A.E.I. motor and control gear division.

GENERAL ELECTRIC COMPANY, Ltd., announces that Mr. V. G. Burchill has been appointed assistant publicity manager and Mr. Roy Herbert has been appointed chief press officer.

THE CENTRAL ELECTRICITY GENERATING BOARD has announced that Mr. S. S. Scott, its chief personnel officer is vacating the appointment on September 30, and is to be succeeded by Mr. Harold C. Spear.

MR. PETER J. FIELD has been appointed public relations officer to the Central Electricity Generating Board in succession to Mr. L. J. Luffingham who, on reaching retiring age, leaves the Board's service.

MR. G. J. LYONS has been appointed secretary of the Institution of Plant Engineers in succession to Mr. R. F. Farmer who has resigned to take up an appointment with the Institution of Civil Engineers.

MR. GEORGE BARNARD who retired from the National Boiler and General Insurance Company, Ltd., early this year has been appointed manager of Manchester and North Midlands area for Norris Consultants, Ltd.

MR. ROBERT G. ALLEN, president of Bucyrus-Erie Company, U.S.A., has been appointed a director of Ruston-Bucyrus, Ltd., Lincoln, and has been elected chairman of the board, to fill the vacancy caused by the resignation for health reasons of Mr. William L. Little.

WALKER, CROSWELLER AND CO., Ltd., announces that its representative in the Midlands, Mr. W. W. Nicholas, has left the company to take up a teaching appointment at Birmingham Technical College. He has been succeeded at Walker Crosweller by Mr. E. W. Tinsley.

BRITISH ROPES, Ltd., announces that Mr. E. D. Nicholson has been appointed general manager of the wire division, and Mr. Stuart Watts general manager of the wire rope division. Mr. Watts has also been appointed a director. Mr. Nicholson has relinquished his post as company secretary and has been succeeded by Mr. J. R. K. Buckley.

Business Announcements

NELDCO PROCESSES, Ltd., Crossway House, Bracknell, Berks, announces that it has been appointed sole agent for the sterling area for "Krebs" cyclones.

STENOR, Ltd., Richmond, Surrey, has appointed M. Silva, Campo das Cebolas 47, 1, Lisbon, as its agent in Portugal. Mr. G. Alexander Fardon, export representative of Stenor, Ltd., has left for a tour of the Continent.

ACME CONVEYORS, Ltd., has now completed the transfer of its detail design, buying and accounts departments, to its office extension at 58-62, Seaward Street, Glasgow, S.1.

MUREX WELDING PROCESSES, Ltd., Waltham Cross, Herts, announces that it has purchased the whole of the issued shares of Donald Ross and Partners, Ltd., Crawley, Sussex.

NORTHERN ALUMINIUM COMPANY, Ltd., states that its London area sales office has removed from Bush House, to 50, Eastbourne Terrace, London, W.2 (telephone Paddington 3281).

THE ELECTRICITY COUNCIL announces that the address of the regional safety officer for the Southern, South Western and South Wales region is now Electricity House, Colston Avenue, Bristol, 1 (telephone Bristol 26062).

KLOCKNER MOELLER ENGLAND, Ltd., has opened a branch office at Permanent House, The Headrow, Leeds. The office will be in the charge of Mr. J. T. Bastow, who has been transferred from Manchester. Mr. G. E. M. Mitchell has been appointed to succeed Mr. Bastow at Manchester.

POWELL DUFFRYN ENGINEERING COMPANY, Ltd., Cambrian Works, Cardiff, has been appointed the licensed manufacturer for the United Kingdom and Europe of "Dempster-Dumpster" container handling vehicles and equipment. "Dempster-Dumpster" is the registered trade mark of Dempster Brothers of Knoxville, U.S.A.

HERCULES POWDER COMPANY, Ltd., 1, Great Cumberland Place, London, W.1, states that it is now able to offer "Penton," chlorinated polyether, for sale in the United Kingdom. "Penton" is manufactured at the Parlin, New Jersey, plant of the parent company, Hercules Powder Company, Inc.

BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., states that, further to its recent announcement that it was purchasing the rotating machines section of Veritys, Ltd., the transfer to its Loughborough works of the total production relevant to that transaction has now been completed. In future all machines manufactured in accordance with Verity designs will be marketed as the Brush-Verity range.

Contracts

DORMAN LONG (BRIDGE AND ENGINEERING), Ltd., has secured from American sources an order worth approximately 2,000,000 dollars for bridgework for Saigon in Vietnam. The contract involves the supply of 5500 tons of steelwork which will be fabricated at the company's bridge and constructional works, Middlesbrough.

DORMAN LONG (STEEL), Ltd., has received from the A.C.D. Bridge Company—a partnership formed by Sir William Arrol and Co., Ltd., the Cleveland Bridge and Engineering Company, Ltd., and Dorman Long (Bridge and Engineering), Ltd.—an order for approximately 7500 tons of high tensile galvanised wire required for the main cables of the suspension bridge under construction across the Firth of Forth. The wire will be 0·192in in diameter with a tensile strength of 100/110 tons to the square inch.

THE HEAD WRIGHTSON MACHINE COMPANY, Ltd., has been awarded contracts for plant valued at over £2,000,000 for the installation of an electrolytic tinning line at the Ebbw Vale Works of Richard Thomas and Baldwins, Ltd., capable of tinning and re-coiling 1500ft of steel strip per minute. Additionally, equipment is being supplied for the preparation of steel strip before it is processed in the tinning line, for tin plate cut-up lines and for equipment to inspect and assort the plate.

FERRANTI, Ltd., has received an order exceeding 250,000 dollars from the Anaconda Wire and Cable Company of Hastings-on-Hudson, New York, for what is believed to be the largest high voltage a.c. cable testing set yet built by a British manufacturer—a 14,000kVA, 250kV a.c. cable testing set capable of supplying 55A for approximately two hours. A second transformer unit is also included which, when connected in cascade, will give an output of 500kV at 6A continuously. The equipment will be designed for controlled series resonant operation for both 250kV and 500kV by means of continuously variable moving coil reactors. Two step-up transformers, one feeder transformer, two moving coil reactors and control desk comprise the complete equipment. Whereas the 300kV, 2400kVA testing equipment recently supplied by Ferranti, Ltd., to Anaconda is for research and development work the new equipment is intended for routine testing of cables.

APPLEBY-FRODINGHAM STEEL COMPANY, a branch of The United Steel Companies, Ltd., is to extend the Frodingham section mills by the addition of equipment to produce universal beams, "I" sections with parallel edges, and column sections. A contract has been placed with Schloemann A.G., Düsseldorf, but the equipment will be manufactured in this country. Schloemann has placed an order with Distington Engineering Company, Ltd., a United Steel subsidiary, for the supply of the mechanical equipment. Work on the project has already begun at Distington, and the new extensions are expected to be in operation by the autumn of 1961.

Miscellanea

HEAT-RESISTANT CONVEYOR BELT.—A new synthetic rubber conveyor belt known as "Star-Hete," which is made to handle hot and abrasive materials, has been developed by the Dunlop Rubber Company, Ltd., Speke, Liverpool, 12, for use in the iron and steel, chemical, cement, and gas industries. This belt has a cover of synthetic rubber which will withstand temperatures of up to 350 deg. Fah.

HAND STRAPPING TOOL.—There is now being made by the Packers Supply Company, Ltd., Agripta House, Burlington Road, New Malden, Surrey, an automatic tensional steel strapping tool which works off any standard airline or small compressor. With it the tension applied can be predetermined by the setting of a calibrated dial on the top of the tool. When a button on the tool is pressed it automatically tensions the strapping to the required degree, seals it, and finally cuts off the surplus strapping close to the seal. The tool weighs about 7 lb and can be supplied for use with ½in, ⅝in and ¾in width strapping in various gauges.

WEIGHT CONTROL EQUIPMENT.—An automatic weighing control equipment for heavy industrial purposes such as maximum weight control on mineral hoists, control of sand in batching hoppers in foundry work, and control of load on lengths of conveyor has been developed by Elcontrol, Ltd., Wilbury Way, Hitchin, Herts. Standard load cells for load support in suspension are connected to a remote relay unit which integrates their output. The integrated output current is monitored and when it reaches a value corresponding to the selected operating weight, a relay in the control unit is operated to actuate the control mechanism. The relay unit consists of a withdrawable chassis housed in a cast weatherproof case suitable for outdoor mounting, or in a sheet steel case with hinged lid for indoor use. It can also be supplied in a flameproof version, Buxton certified and intrinsically safe. The equipment is suitable for the range of weights normally covered by standard load cells, from 50 lb up to 1000 tons or more, and is provided with operating adjustment over any desired range of weights. A repetitive accuracy of better than 1 per cent is claimed.

IMPROVEMENT OF THE BARNET BY-PASS.—The Ministry of Transport and Civil Aviation, announces that work is about to start on the construction of a second carriageway, 24ft wide and about 4 miles in length, alongside the Barnet By-pass A.1 from a point to the north of Apex Corner as far as the proposed junction with the South Mimms By-pass south of Bignells Corner. Large new roundabouts will be constructed at the junction of A.1 with A.411 at Stirling Corner and at the northern end of the scheme where it will link up with the South Mimms By-pass, the diverted northern end of A.1081 from Barnet and eventually with the proposed "D" ring road. Rowley Lane will be taken over the by-pass at a fly-over junction with slip roads for turning traffic. Included in the scheme will be a length of about 2130 yards of carriageway to be constructed as a specification trial with two different thicknesses of asphalt surfacing. Full-scale experiments have already been carried out successfully with these specifications and the proposed trial, the Ministry states, is to test the specifications under normal contract conditions. A scheme for "dualling" the southern end of the by-pass down to Apex Corner will follow shortly, the Ministry states. The Barnet By-pass lies partly in Hertfordshire and partly in Middlesex, but design and supervision is to be carried out by the County Surveyor of Middlesex, Mr. H. S. Andrews, M.I.C.E. The design of the fly-over bridge has been prepared by Leslie Turner and Partners. The tender of John Laing and Son, Ltd., for both road and bridge works at a figure of £538,277 6s. 10d. has been accepted. The whole of this cost will be met by the Ministry of Transport and Civil Aviation. Work is planned to take seventeen months.

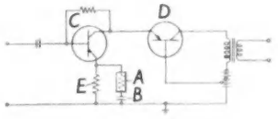
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings unless otherwise stated. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

ELECTRONICS

812,977. March 29, 1956.—Temperature-Compensated Transistor Amplifier, General Electric Company, Schenectady 5, State of New York, United States of America.

It is an object of this invention to provide a new and improved transistor amplifier circuit which will maintain a substantially constant power output over a wide temperature range. Transistors are highly temperature sensitive, particularly when used in power output stages due to large power dissipation in these stages which increases the junction temperatures. It has been found that in order to compensate for decreases in power output with increasing temperature, it is necessary to vary the input signal so that the input signal increases with increasing temperatures. This is accomplished in



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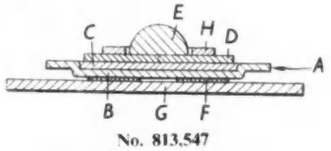
the drawing by providing a degenerative feedback path which in this case includes temperature-sensitive resistance *A* in series with blocking capacitor *B* in the emitter circuit of transistor *C*. Variations in the resistance due to temperature changes cause variations in current amplification, which in turn vary the drive on transistor amplifier *D*, thus providing the desired compensation. In the arrangement shown, resistance *A* must decrease with increasing temperature to provide a current amplification which increases with temperature. An additional effect of connecting resistance *A* across biasing resistor *E*, is that the input resistance of transistor *C* decreases with increasing temperature. It should be noted that by using blocking capacitor *B*, the amount of degeneration will not affect the d.c. operating point of the transistor. An alternative circuit is illustrated in which the degenerative feedback path is connected between the collector and base electrodes of the transistor.—*May* 6, 1959.

813,547. July 2, 1957.—Forming a Junction in a Semiconductor, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2. (*Inventors: Ralph David Knott and Michael Rupert Platten Young.*)

The invention is concerned in particular with methods of forming a junction in a semiconductor in which a substantially planar junction of relatively large area may be formed without necessitating any complex means for locating the semiconductor body during the formation of the junction. Referring to the drawing, a circular nickel plate *A* having a diameter of about 6mm and having a central dished portion *B* about 4·5mm in diameter and about 0·5mm deep, is cleaned by heating in a hydrogen atmosphere, and a small quantity of indium *C* is pressed into the dished portion by means of a steel punch. The germanium plate *D* is then placed centrally on the virgin surface of the indium body.



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Pressure is then applied to the germanium so that it is bonded to the indium body. A hemi-spherical bead *E* of indium, 1·5mm in diameter, is cold bonded centrally to the upper main face of the germanium plate to form the emitter electrode of the transistor. The germanium plate assembly is mounted in a jig with the nickel plate resting on a solder washer *F* placed on a copper disc *G*, the disc being designed to form part of the envelope of the transistor. A gold-antimony alloy ring *H*, having an internal diameter slightly greater than the diameter of the indium bead and an outer diameter approximately equal to the length of the sides of the germanium plate is placed symmetrically around the indium bead on the top surface of the germanium plate. The whole assembly as shown in the drawing is heated to a temperature of about 550 deg. Cent. in an atmosphere of pure dry hydrogen and is then allowed to cool. By this means the gold-antimony alloy ring is soldered to the germanium plate to form a base connection, the nickel plate is soldered to the copper disc and the parts of the indium body and the indium bead respectively in contact with the main faces of the germanium plate are fused to the plate so as to form the electrodes of the transistor; at the base of each electrode is formed a p-n junction separating the main body of n-type germanium from a layer of p-type germanium formed by recrystallisation from the indium-germanium alloy produced during the heating. The envelope of the transistor is completed by cold pressure welding to the copper disc a copper cup arranged to enclose the germanium plate assembly.—*May* 21, 1959.

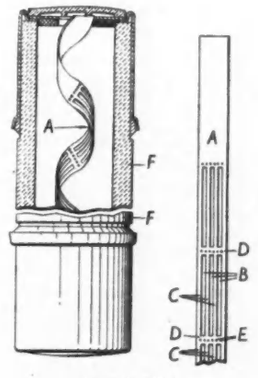
814,523. August 30, 1955.—Level Indicating System, Babcock and Wilcox, Ltd., Babcock House, Farringdon Street, London, E.C.4. (*Inventor: Thomas Ferlie Dryden.*)

When presence or absence of material at a given level is detected by variation of the capacity of a probe covered or uncovered by the material, it is a disadvantage that the system is very sensitive to stray capacity of the electric conductor leading to the probe and that the capacity of the conductor must not be large compared with that of the probe when covered by the material. Hence, the length of the conductor, which actually is quite critical, must be short. According to this invention the probes are connected by transmission lines to a source of oscillatory pulses. Each line is a multiple or substantially a multiple in length of quarter-wavelengths of the oscillatory frequency. When the upper probe is covered by the material, its transmission line is incorrectly terminated and strong reflections occur which oppose the oscillations. This closes a pair of relay contacts and connects the lower probe to the oscillator, so that oscillations continue at a reduced level until this lower probe, also, is uncovered by the falling level of the material. On this occurring, the increased magnitude of the oscillatory pulses reverses the relay contacts, disconnecting the lower probe and leaving only the connection to the upper probe, the stronger oscillations continuing until the rising level of the material reaches the latter. Various warning and control devices may be operated from the system. Since operation does not depend upon a change in capacitance of a portion of the oscillatory circuit, self capacitance in a probe is of little importance and, consequently, mechanical strength can be accorded first consideration. Moreover, the maintaining of the transmission line sheath at earth potential eliminates the effect of stray external capacity. Two types of probe are illustrated in the specification, one of them having provision for dislodging by compressed air any solid material such as damp pulverised coal which may tend to adhere to the probe rod.—*June* 10, 1959.

ELECTRICAL ENGINEERING

813,643. May 6, 1957.—Elements for High Rupturing Capacity Electrical Fuses, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2. (*Inventor: William James Elliott.*)

It is usual in h.r.c. cartridge fuses to wind an element spirally to reduce the overall length of fuse for a given element length. The element may have a



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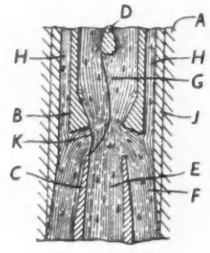
number of parallel sections, forming virtually a series of elements connected in parallel, and the difficulty then occurs that the sections may be displaced relatively to one another. This is particularly the case when the cartridge type fuse is to be filled with arc quenching material, and it is an object of the present invention to provide a fuse element the parallel sections of which are retained in position relative to one another both during the filling of a cartridge type fuse and subsequently without the aid of a core. Three forms of element are described in the specification. In one of these, shown in the drawings, a length of strip of silver or other suitable fusible material forming the element *A* has punched out of it a number of longitudinal slots *B*, three slots to the width of the strip to form parallel fuse sections *C* over the major part of the length of the strip. At the termination of each group of three slots, the solid strip forms a tie *D* in which a row of small holes *E* is punched; the number of slots per group chosen is quite arbitrary and may be more or less than three. A further group of three slots then follows, succeeded by another tie similarly punched and so on. The element *A* blanked or punched in this fashion is wound into a spiral and inserted into the body of the fuse *F*. No core is used and the presence of the ties *D* ensures that the position of the parallel elements *C* relative to one another is maintained during filling of the fuse with quenching material and subsequently. The row of holes on the ties acts as a cut-off to safeguard the fuse against excessive peak currents when clearing short circuit faults.—*May* 21, 1959.

813,683. February 3, 1956.—Gas-Blast Electric Switchgear, The English Electric Company, Ltd., Queens House, 28, Kingsway, London, W.C.2. (*Inventors: Eric Bolton and John Hewitt.*)

This invention relates to electric switchgear of the gas-blast type and is concerned with the provision, in an axial-blast interrupter, of interrupting contacts designed primarily to ensure a high voltage breakdown strength between the contacts when open. Referring to the drawing, an insulating housing *A* contains the interrupting contacts *B* and *C*. Of these contacts, contact *B* (the "throat" contact) is situated downstream of the arc region and contact *C*, which will be referred to as the "nozzle" contact, is situated upstream of the arc region, the direction of flow of air in this figure being upwards. An arc probe *D* is situated within the throat contact. In this embodiment of the invention the throat contact is movable for circuit interruption and completion and the blast of air is initiated and controlled by a



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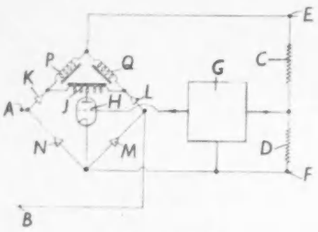
blast valve at the lower end of the insulator *A*. When the interrupting contacts *B* and *C* are open and the blast valve, not shown in this figure, is also open, air under pressure flows to the arc region through the bore *E* of the nozzle contact and also through the annular passage *F* between it and the wall of the housing. The cross-sectional area of the bore *E* is between one-eighth and one-quarter of the combined cross-sectional area of the bore and the passage *F* so that the greater amount of air flows to the arc region through the passage *F* outside the contact *C*. Air can flow away from the arc region both through the bore *G* of contact *B* and through the annular passage *H* surrounding it. The nozzle contact tapers slightly at its upper end. The wall of the enclosure surrounding the contacts is also made to taper inwardly by the provision of an insulating sleeve *J*, or by suitably shaping the insulator *A*. Thus air approaching the arc region either through the bore *E* or through the annular passage *F* encounters a throat-like constriction which directs it towards the actual vicinity of the arc and also slightly increases its velocity. During an on-load opening operation of the interrupter the arc is initially formed between opposed surfaces of the contacts *B* and *C*, the arc being indicated diagrammatically at *K*. Thus the arc is subjected to a strong blast of air passing from the annular passage *F* into the bore of the throat contact and is quickly swept into the throat and transferred to the arc probe. This latter condition is shown at *L*. The action of interrupting contacts of the design illustrated greatly assists the extinction of the arc at a current zero by virtue of the cooling action of the airstream on the arc.—*May* 21, 1959.

ELECTRICAL ENGINEERING

814,833. August 29, 1957.—VOLTAGE REGULATORS, S. Smith and Sons (England), Ltd., Cricklewood Works, Cricklewood, London, N.W.2. (*Inventor : Desmond Charles Pinkney.*)

According to this invention a device for providing a regulatable direct voltage output from an alternating source comprises an arrangement of half-wave rectifiers, saturable reactors, and a controlled impedance in the form of a triode valve. Referring to the diagram, *A* and *B* are the a.c. input terminals.



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Resistors *C* and *D* are connected between the d.c. output terminals *E* and *F* so that a definite fraction of the output voltage appears across resistor *D*. This fraction is applied to a comparator *G* which develops a d.c. output dependent on the discrepancy between the actual and desired values of the voltage across *D*. This output is applied to the grid of valve *H*, thus controlling the impedance presented by it between the centre tap of inductor *J* and the output terminal *F*. Rectifiers *K*, *L*, *M*, *N* are connected in a form of bridge circuit, and *P*, *Q* are saturable reactors. When either saturates on one input half-cycle, a flux level is established in the other, the r.m.s. output depending on the effective resistance of triode *H*, decreasing with decreasing effective resistance.—*June* 10, 1959.

METALLURGY

816,609. April 25, 1957.—RECOVERY OF VANADIUM FROM SLAG, The United Steel Companies, Ltd., 17, Westbourne Road, Sheffield, 10. (*Inventors : Lewis Reeve and Frederick Walter Thrupp.*)

In Specification No. 737,889 there was described a process for the recovery of vanadium from vanadium-containing slags produced during the production of iron or steel, the process comprising chloridising the slags with hydrogen chloride (gaseous HCl) at a temperature between 650 deg. and 850 deg. Cent. to form and distil volatilisable chlorides, and subsequently separating some or all of the chloride of vanadium from the iron chloride. The use of such high chloridising and distillation temperatures is extremely undesirable. According to the invention the slag is now treated with aqeuous hydrochloric acid to dissolve the vanadium as vanadium chloride, the resulting chloride solution being evaporated to dryness. The vanadium is distilled as chloride from the dried residue in the presence of hydrogen chloride gas at a temperature not exceeding 400 deg. Cent. and preferably in the range of 150 deg. to 300 deg. Cent. This reduction in the temperature in the step of removing the vanadium chloride in the gaseous form is highly advantageous. Apart from the direct saving in heat which follows from the reduction in the temperature required for the distillation step, there is also the advantage that cheaper materials of construction can be used.—*July* 15, 1959.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

CIRCULAR GEAR SHAVING CUTTERS : ACCURACY

No. 2007 : 1959. Price 4s. This revised publication deals with serrated circular gear shaving cutters for the production of crowned and uncrowned external and internal gears. The cutters are for use in the automobile industry as well as for turbine reduction gears and for general work. Thus, the scope of the eleven-page specification is broader than that of the previous (1953) edition—which dealt primarily with cutters for shaving marine reduction gears. Tolerances and requirements for cutter bores and spindle diameters have, of course, been brought into line with present-day needs.

HIGHER TENSILE STEEL SHACKLES

No. 3032 : 1958. Price 7s. 6d. This new publication, like the standard for mild steel shackles (B.S. 825) which it complements, specifices small and large sizes of dee- and bow-shackles having six alternative types of pin ; and grab-shackles with special screw pins for use with Bordeaux connections. The safe working loads are ¼–80 tons for dee-shackles and 1–12 tons for grab-shackles, and compared with those of mild steel, the proportions of the shackles specified are smaller.

Form, dimensions, material, workmanship, heat treatment, threads, proof testing, inspection, marking and certification are specified in the new standard. A preliminary description is given of the purposes of the different types of shackles with proportions and weights ; and references are provided to specifications for associated lifting tackle components. Design principles are explained in an appendix.

Code of Practice

PRACTICE FOR TILE FLOORING AND SLAB FLOORING

Code 202 : 1959. Price 5s. All work involved in the laying of clay tile or concrete tile flooring, brick flooring and natural or cast stone flooring bedded on a solid base is dealt with in this revised code of practice. It also provides guidance on the influence of site conditions on the base and floor covering. The relationship between base (solid and suspended floor construction) and finish is discussed at length, particularly in regard to failures arising from the variable stress in the base and finish—which leads to recommendations for bedding the floor finish on a separating layer. The durability of the recommended floor finishing materials is considered.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Mon., Sept. 28.—N.W. LONDON BRANCH : Compass Hotel, Watford, "Composition of the A.S.E.E.," W. J. Wheeler, 8.15 p.m.

Fri., Oct. 2.—LIVERPOOL AND DISTRICT BRANCH : Industrial Development Centre, M.A.N.W.E.B., Paradise Street, Liverpool, 1, "The National Inspection Council—Its Aims and Objects," E. J. Sutton, 7.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Sept. 30.—LONDON BRANCH : London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Modern Microwave Valves : A Survey of Evolution, Principles of Operation and Basic Characteristics," W. E. Willshaw, 6.30 p.m. ★ TREFOREST BRANCH : Glamorgan College of Technology, Treforest, Glam, "The Use of Demonstration Equipment in Basic Radio Theory," H. Henderson, 6.30 p.m.

Fri., Oct. 2.—S. MIDLANDS SECTION : North Gloucestershire Technical College. "Loudspeakers," F. H. Brittain, 7 p.m.

Wed., Oct. 7.—COMPUTER GROUP : London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1, "Some Reflections on Computer Design," W. Renwick, 6.30 p.m. ★ S.W. SECTION : School of Management Studies, Unity Street, Bristol. Annual General Meeting, 6 p.m. Chairman's Address, "The Drift of Electronics," L. Hix, 6.30 p.m. ★ S.W. SECTION : R.A.F. Radio Apprentices School, Locking, near Weston-super-Mare. Symposium on "The Training of Radio Apprentices." 10.30 a.m.–4.30 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Wed., Oct. 7.—SCOTTISH REGION : Grand Hotel, Charing Cross, Glasgow. Brains Trust on "Clean Air and Industry," 10 a.m. A discussion on "Instrumentation and Smoke Control," opened by P. J. Turner, 2 p.m.

INDUSTRIAL WELFARE SOCIETY

Mon., Sept. 28.—Robert Hyde House, 48, Bryanston Square, London, W.1, "Changes in Industrial Law—the New Factories Act Explained," H. Samuels, 2.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Mon., Oct. 5.—STUDENT LECTURE : The Memorial Building, 76, Mark Lane, London, E.C.3, "Watchkeeping and Maintenance in a Motor Ship," S. Speed, 6.30 p.m. ★ MERSEYSIDE AND N.W. SECTION : Liverpool Engineering Society, The Temple, Dale Street, Liverpool, "Marine A.C. Distribution Equipment with particular reference to H.R.C. Fuses," M. J. Bolton, 6 p.m.

Tues., Oct. 6.—The Memorial Building, 76, Mark Lane, London, E.C.3, Presidential Address, Sir William Wallace, 5.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., Oct. 6.—Geological Society, Burlington House, Piccadilly, London, W.1, "The Controlled Crystallisation of Sodium Chloride," J. Bain and F. Rumford, 5.30 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Wed., Oct. 7.—MIDLAND BRANCH : Queens Hotel, Birmingham, "Titanium and its Alloys for Chemical Plant," B. J. Conolly, 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Oct. 6.—39, Elmbank Crescent, Glasgow, Presidential Address, J. Brown, 6.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Oct. 5.—S. MIDLAND CENTRE : Grand Hotel, Birmingham. Annual General Meeting, Chairman's Address, G. F. Peirson, Conversazione.

INSTITUTION OF MECHANICAL ENGINEERS

Thurs., Oct. 1.—SCOTTISH BRANCH : Royal College of Science and Technology, Glasgow, "New Methods of Exploiting Electronic Computers in the Engineering Industry," H. MacGregor Ross, 7.30 p.m. ★ YORKSHIRE BRANCH : Visit to British Railways Locomotive Works, Doncaster, 2.30 p.m. Mansion House, Doncaster, "The 'Deltic' Locomotive," C. M. Cock, 6.30 p.m.

Mon., Oct. 5.—WESTERN BRANCH : Visit to Berkeley Nuclear Power Station, Gloucestershire, 10 a.m.

Tues., Oct. 6.—AUTOMOBILE DIVISION : 1, Birdcage Walk, Westminster, London, S.W.1, Annual Meeting, 6 p.m., Chairman's Address, "Some Problems We Met," L. H. Dawtrey, 6.30 p.m. ★ SOUTHERN GRADUATES' SECTION : Technical College, Brighton, Film Show, 7 p.m.

INSTITUTION OF NAVAL ARCHITECTS

Wed., Oct. 7.—10, Upper Belgrave Street, London, S.W.1, "The Prospect for a Nuclear Powered Dry Cargo Liner," E. C. B. Corlett and E. P. Hawthorn, 4.45 p.m.

INSTITUTION OF NAVAL ARCHITECTS AND INSTITUTE OF MARINE ENGINEERS

Wed., Sept. 30.—SOUTHERN JOINT BRANCHES: Portsmouth College of Technology, Anglesea Road, Portsmouth, "Some Aspects of the Design and Construction of All-Welded Small Craft," Robert du Cane, 7.30 p.m.

INSTITUTION OF PLANT ENGINEERS

To-day, Sept. 25.—BIRMINGHAM BRANCH : Imperial Hotel, Temple Street, Birmingham, "Works Engineering," R. T. Wells, 7.30 p.m.

Mon., Sept. 28.—WEST AND EAST YORKSHIRE BRANCH : Houldsworth School of Applied Science, The University, Leeds, "Operational Research," G. D. Jordan, 7.30 p.m.

Tues., Oct. 6.—EDINBURGH BRANCH : 25, Charlotte Square, Edinburgh, "Changes in Factory Legislation," A. Gow, 7 p.m. ★ LONDON BRANCH : Royal Society of Arts, John Adam Street, Adelphi, Strand, London, W.C.2, "Packaged Boilers," I. F. G. McVicker, 7 p.m. ★ PETERBOROUGH BRANCH : White Lion Hotel, Church Street, Peterborough, "The Diesel Electric on British Railways," C. Morris, 7.30 p.m.

Wed., Oct. 7.—SOUTHERN BRANCH : Polygon Hotel, Southampton, "Town Planning and the Location of Industry," Roland J. Roddis, 7.30 p.m.

Thurs., Oct. 8.—NORTH-EAST BRANCH : Roadway House, Oxford Street, Newcastle upon Tyne, "Recent Developments in Steelmaking Process," S. G. Cope, 7 p.m.

Fri., Oct. 9.—BIRMINGHAM BRANCH : Hotel Leofric, Coventry, Open Forum, 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Wed., Sept. 30.—SHREWSBURY SECTION : Technical College, Shrewsbury, "Uses and Developments of Work Study," W. C. Castledine, 7.30 p.m. ★ LOUGHBOROUGH COLLEGE STUDENT SECTION : Visit to J. Lucas, Ltd., S. Block Restaraant, Farm Street, Hockley, Birmingham, 2 p.m.

Thurs., Oct. 1.—LONDON GRADUATE SECTION : Visit to Associated Motor Cycles, Plumstead, 2.30 p.m.

Tues., Oct. 6.—COVENTRY GRADUATE SECTION : Craven Arms, High Street, Coventry, "Concerning Gleason Methods and Machines," 7.15 p.m.

Wed., Oct. 7.—SCOTLAND REGION : Windmill Hotel, Arbroath, "Numerical Control of Machine Tools," Messrs. Brett and Tack, 7.30 p.m. ★ NORTH MIDLANDS REGION : The Reform Club, Victoria Street, Nottingham, "The Use of Plastics for Making Jigs, Tools and Moulds," P. G. Pentz, 7 p.m. ★ LONDON, BRIGHTON GROUP : Old Ship Hotel, Brighton, "Nylon and the Production Engineer," E. M. Elliott, 7 p.m.

Thurs., Oct. 8.—NORTH MIDLANDS REGION : Evening Visit to the Imperial Typewriter Company, Ltd., East Park Road, Leicester "The Production Control System at the Imperial Typewriter Company," B. S. Pears, 7.15 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Thurs., Oct. 1.—11, Upper Belgrave Street, London, S.W.1, Presidential Address, L. E. Kent, 6 p.m.

Tues., Oct. 6.—NORTHERN COUNTIES BRANCH : Neville Hall, Newcastle, Chairman's Address, W. R. Garrett, 6.30 p.m. ★ NORTHERN IRELAND BRANCH : Civil Engineering Department, Queen's University, Belfast, "Prestressed Concrete Manufacture and Construction with Special Reference to a Factory in Northern Ireland," K. Brown, 6.30 p.m.

Thurs., Oct. 8.—NORTHERN COUNTIES BRANCH : Cleveland Scientific and Technical Institution, Middlesbrough, Chairman's Address, W. R. Garrett, 6.30 p.m.

Fri., Oct. 9.—WESTERN COUNTIES BRANCH : University Engineering Laboratories, Bristol, Chairman's Address, Peter Gardiner, Presentation of the Francis Memorial Prizes, 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS

Fri., Oct. 2.—FILM EVENING : Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "The Tallylyn Railway—Problems in Preserving a Victorian Narrow-Gauge Railway," 7 p.m.

Wed., Oct. 7.—MIDLAND SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, Annual General Meeting and Chairman's Address, "Some Aspects of Contracts," R. Crawford, 7 p.m.

Fri., Oct. 9.—LONDON SECTION : Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Some Aspects of Industrial Space Heating," D. E. Edminson, 7 p.m. ★ NORTH WESTERN SECTION : Engineers' Club, Albert Square, Manchester, President's Address, 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

Fri., Oct. 9.—Engineers' Club, Albert Square, Manchester, 2, Inaugural Address, M. Bentham, 6.45 p.m.

NEWCOMEN SOCIETY

Wed., Oct. 7.—Science Museum, Kensington, London, S.W.7, Annual General Meeting ; "Davies Gilbert, Patron of Engineers, (1767–1839) and Jonathan Hornblower," A. C. Todd, 5.30 p.m.

SOCIETY OF ENGINEERS

Mon., Oct. 5.—Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1, "Compressed Air in Coal Mines," Neville Smith, 5.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., Sept. 29.—CONTROL SECTION : Manson House, 26, Portland Place, London, W.1, "An Engineer's Approach to a Servo Problem," H. Clausen, 6.30 p.m.

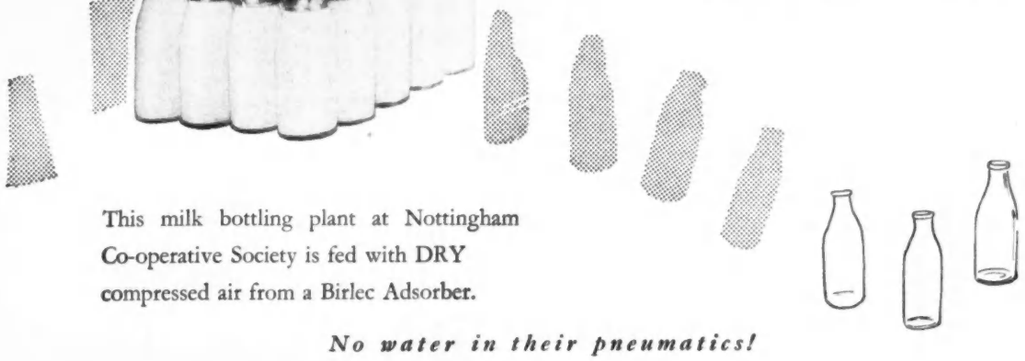
Wed., Sept. 30.—SOUTH WALES SECTION : Physics Lecture Theatre, Welsh College of Advanced Technology, Cardiff, "Force Balance Pneumatic Control," O. G. Pamely-Evans, 6.45 p.m.

Mon., Oct. 5.—CHELTENHAM SECTION : Belle Vue Hotel, Cheltenham, "Record Reproduction Equipment," E. W. Mortimer, 7.30 p.m.

dry pneumatics

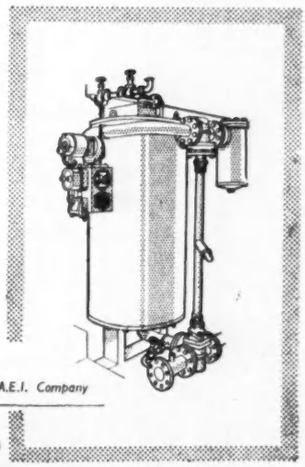
Water vapour is always present in compressed air, building up unseen corrosion, blockages and, finally, expensive maintenance problems.

Birlec Adsorbers banish water worries and problems dry up!



This milk bottling plant at Nottingham Co-operative Society is fed with DRY compressed air from a Birlec Adsorber.

No water in their pneumatics!



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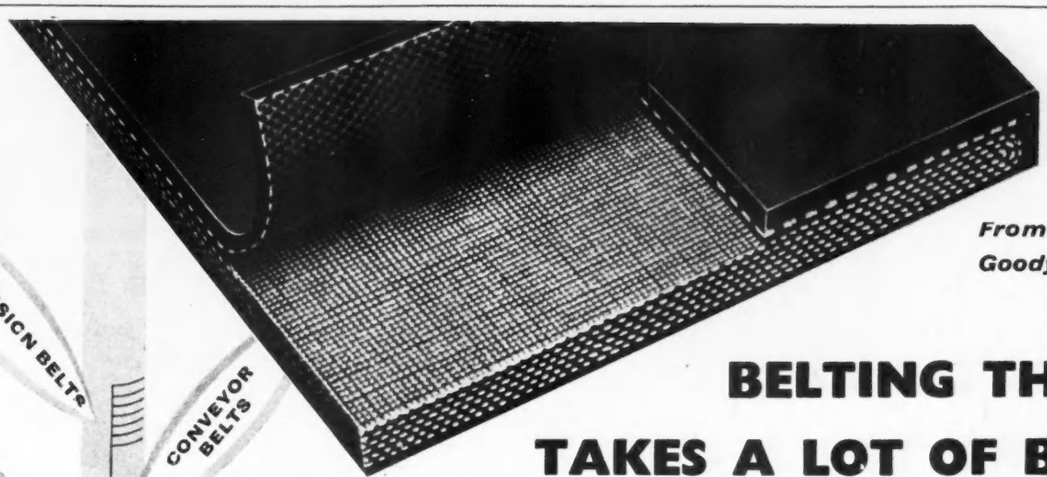

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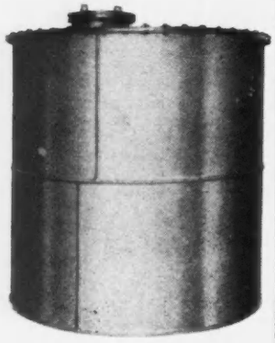

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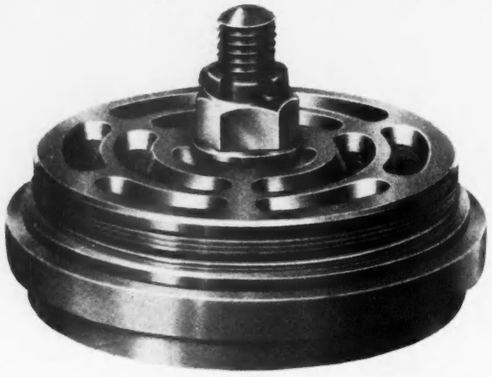

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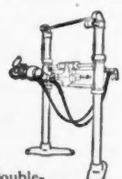

Double-column gantry tubestand

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* *Let Marconi engineers help you in your choice of mountings. In addition to those shown, other tubehead mountings are available to suit specialized requirements. Full details gladly sent on request. MAY WE ALSO SEND YOU PARTICULARS ABOUT OTHER MARCONI INDUSTRIAL X-RAY EQUIPMENT?*

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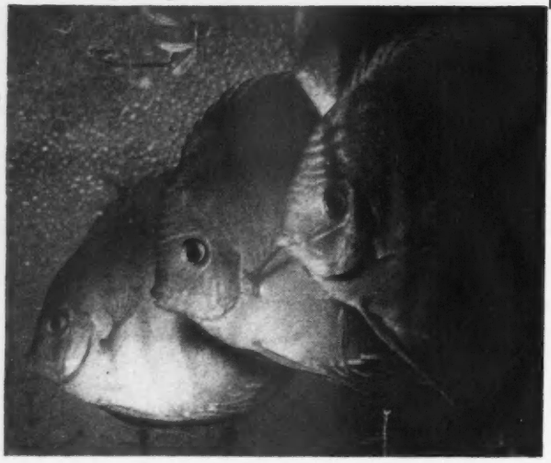
IX 22

this is no fishy story . . .



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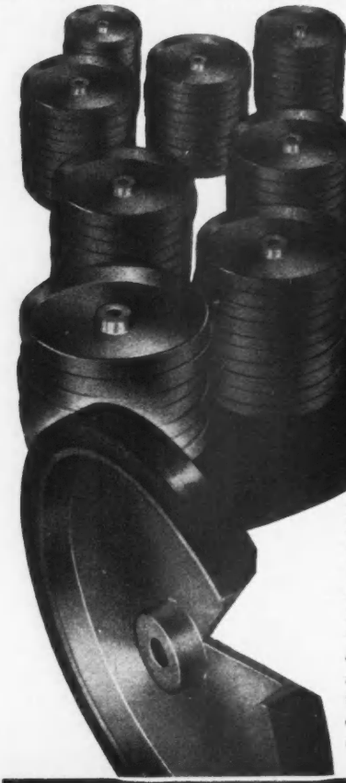

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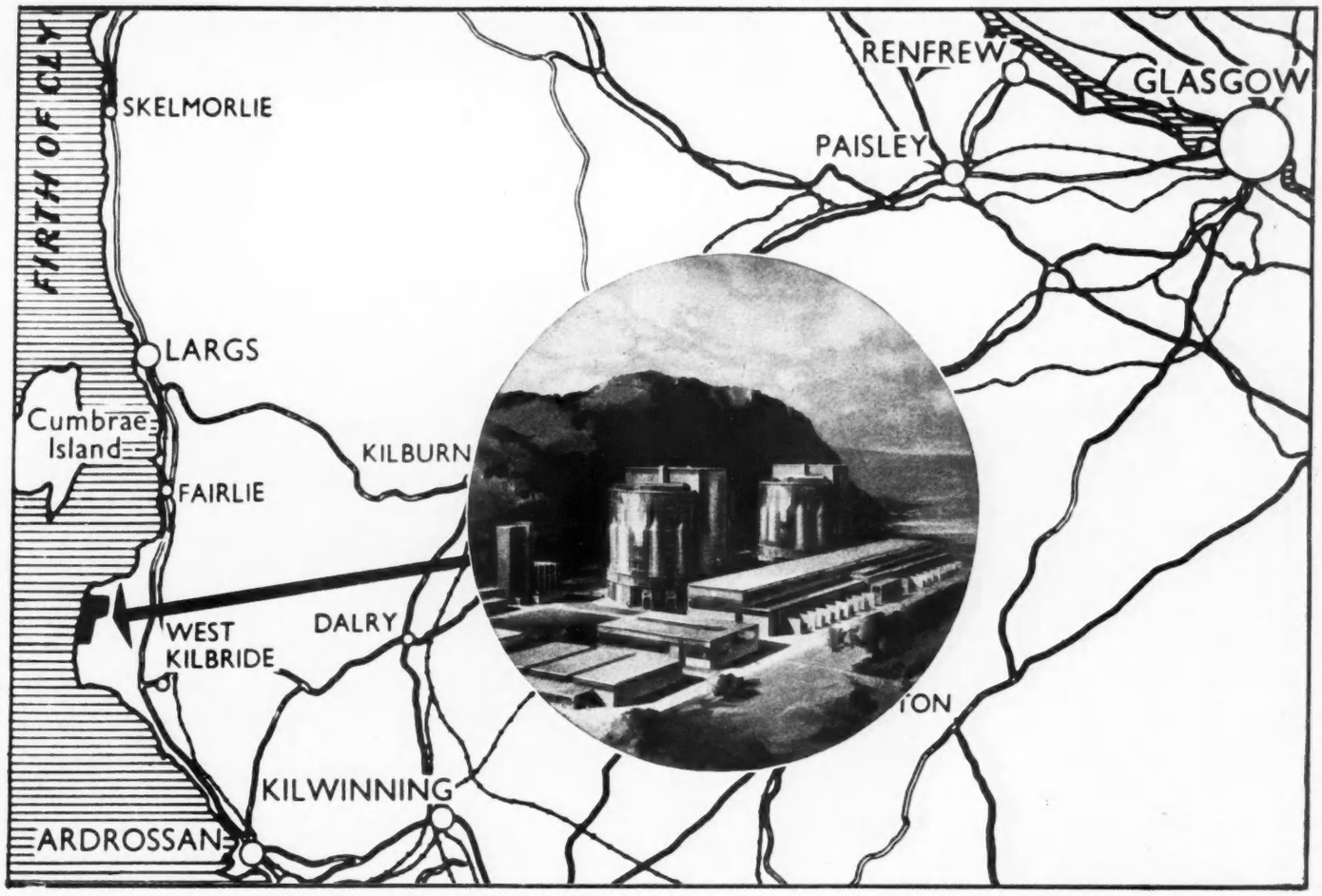

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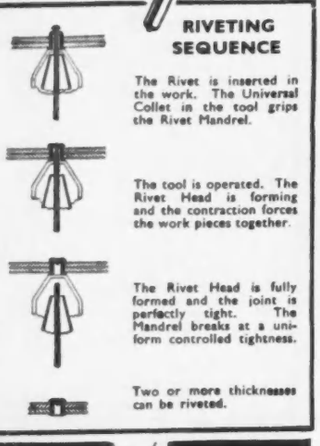
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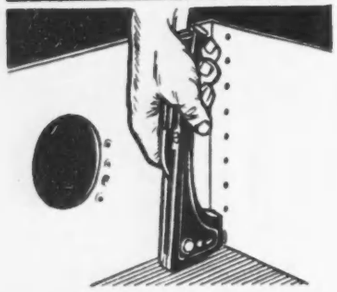

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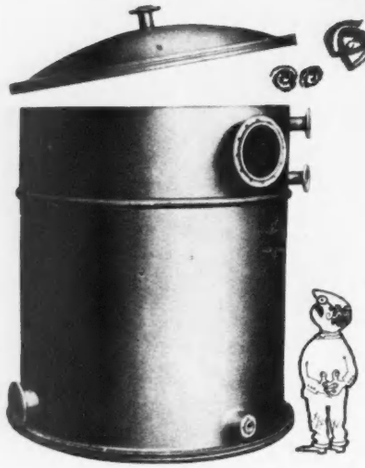

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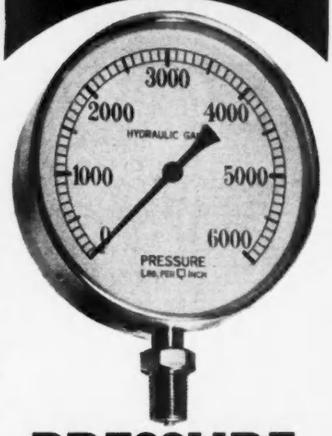

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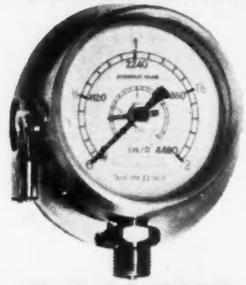

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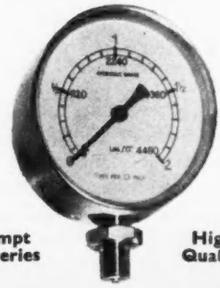

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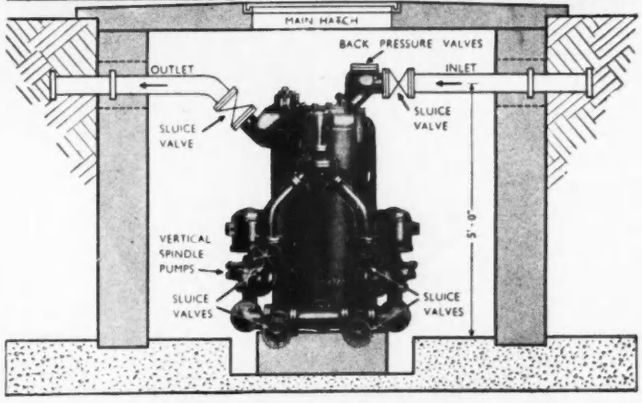

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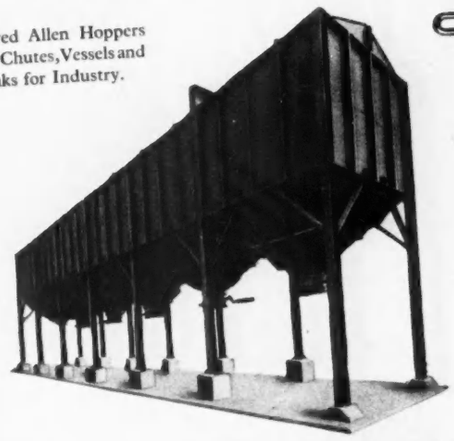

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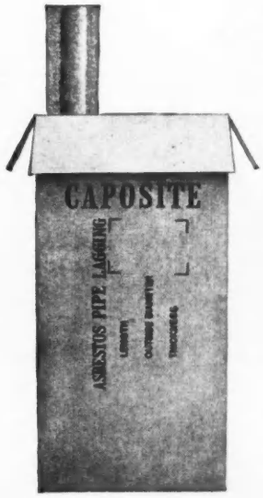

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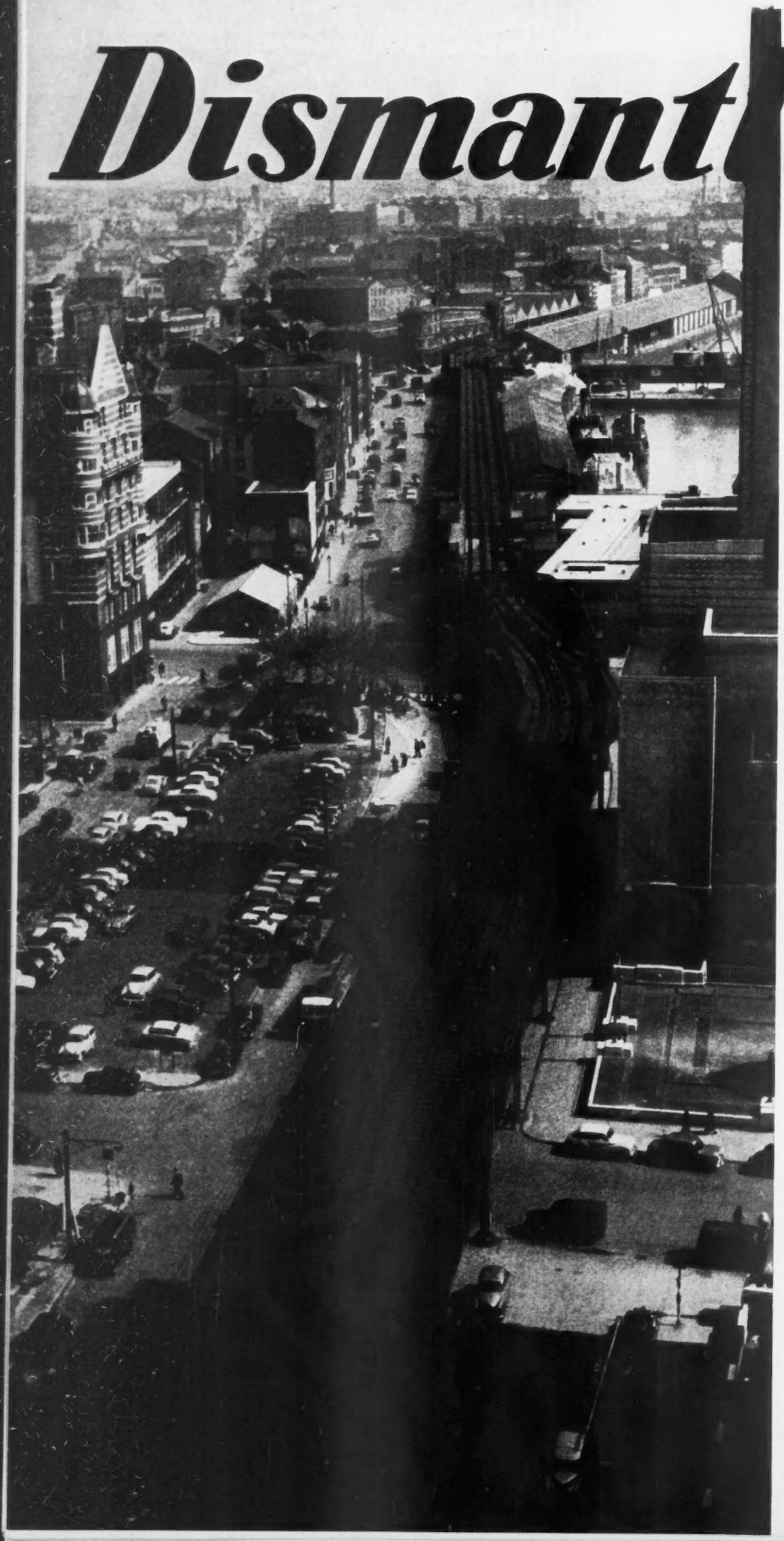

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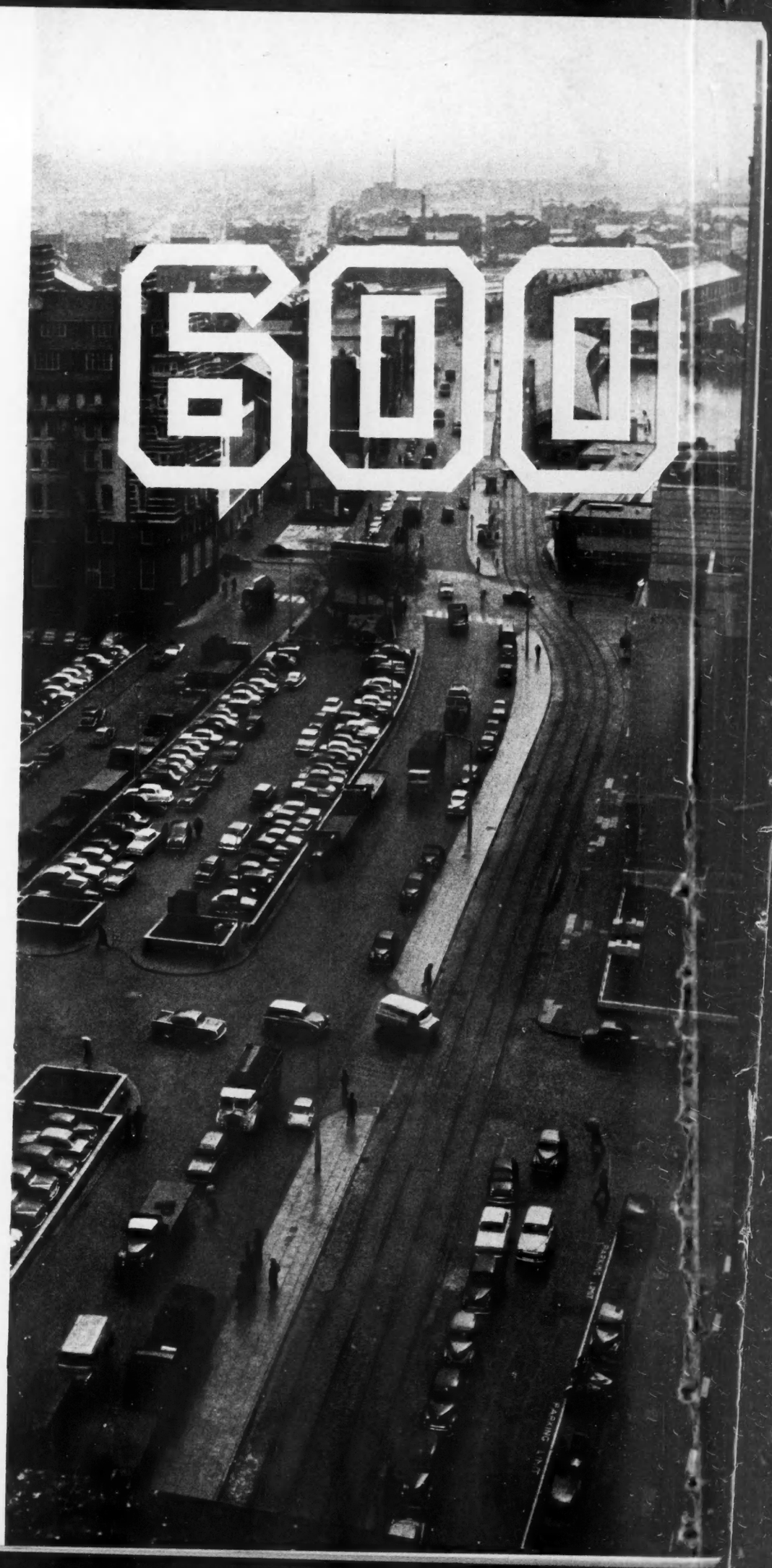

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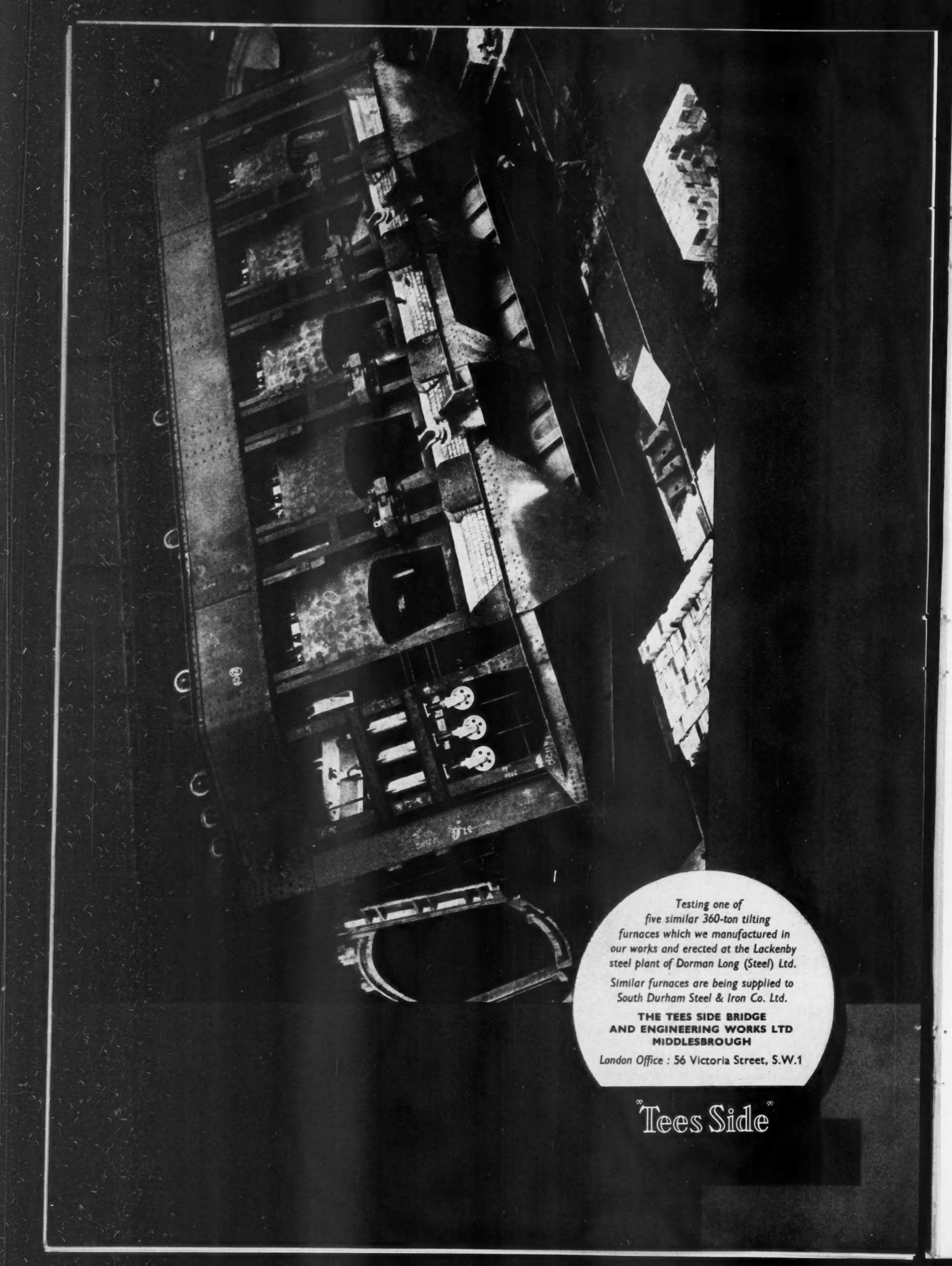

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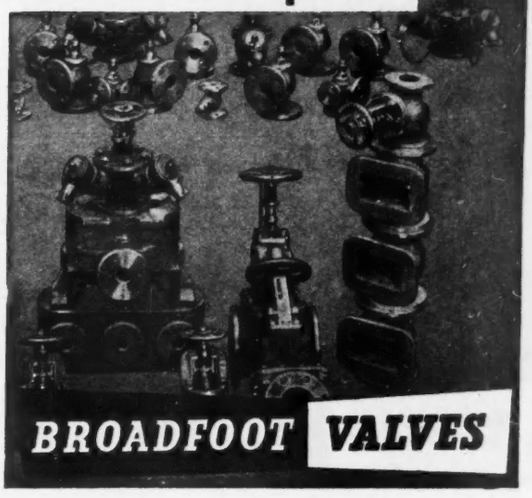

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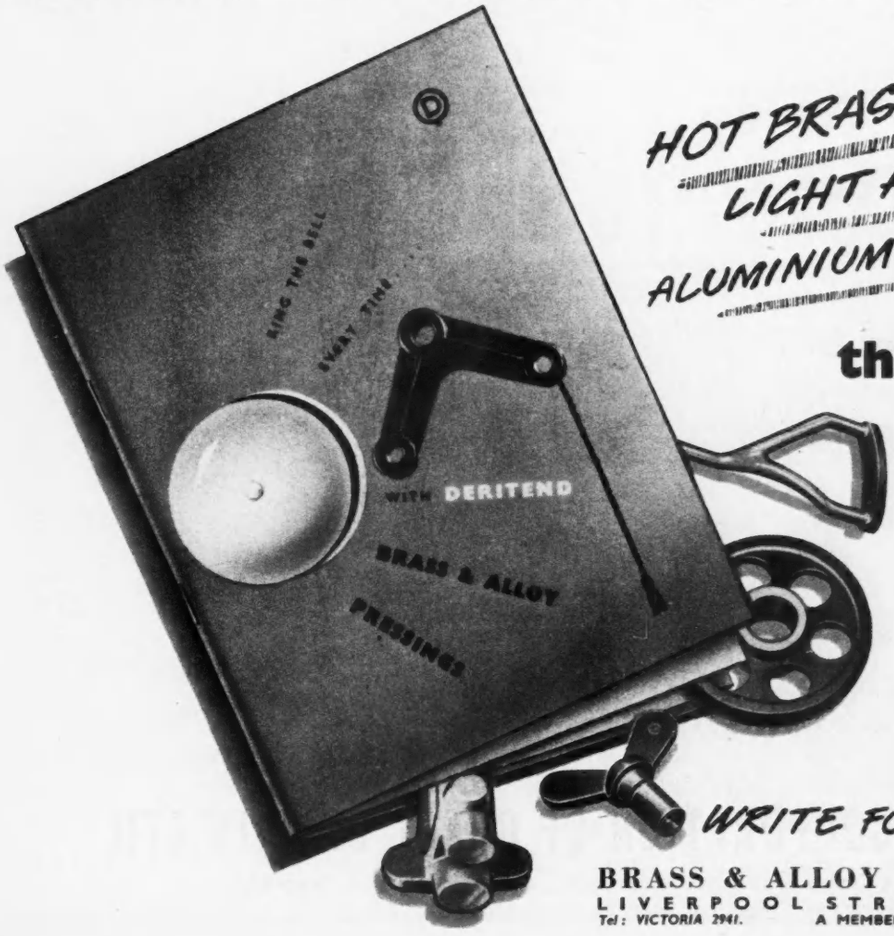

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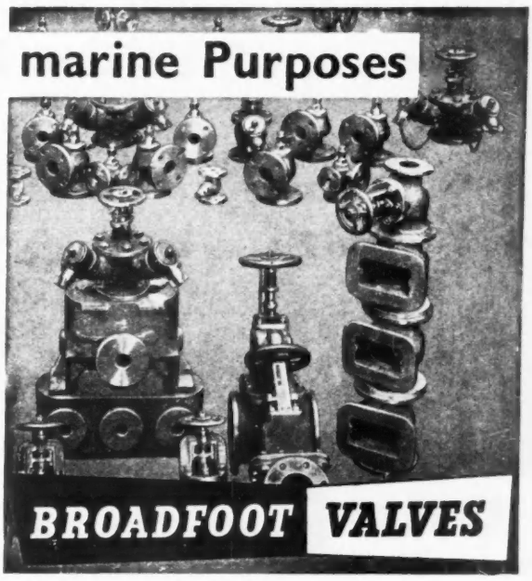

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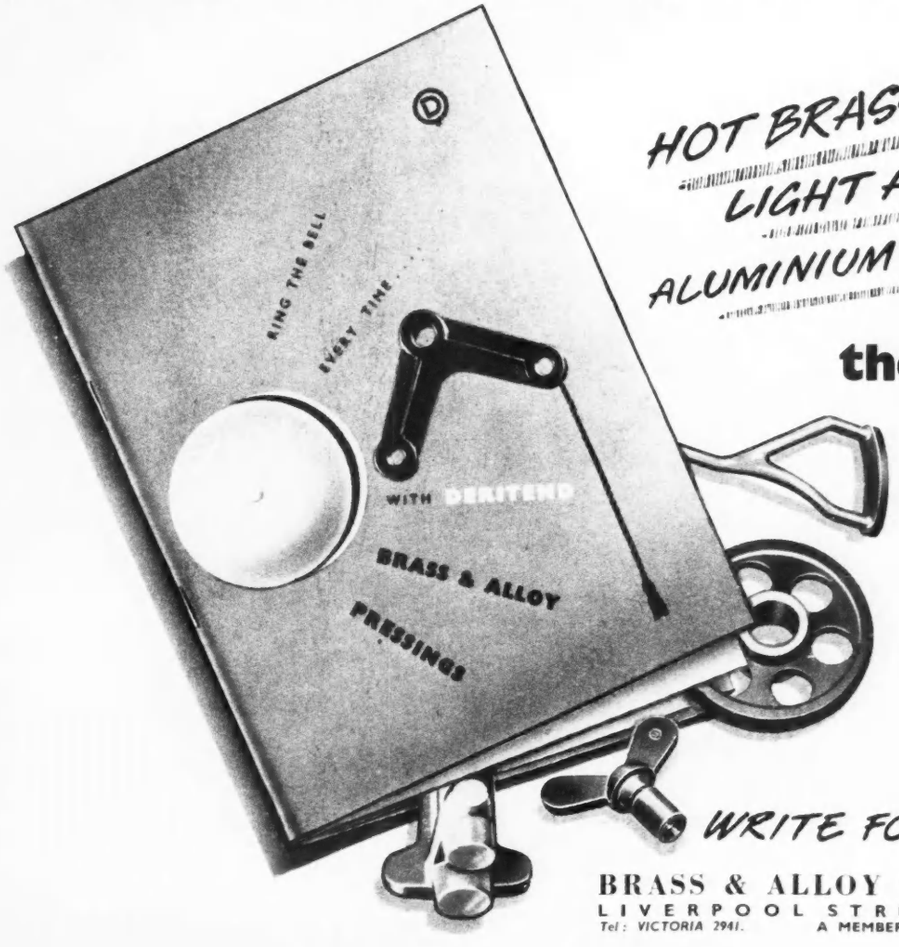

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A Herbert No. 14/36 Combination Turret Lathe, with special tooling for machining cylinder engine liners, installed in the Rugby Works of the English Electric Company. Machined in a total time of 5 hours, four operations. External diameters are held to ±0·001in., bore parallel, concentricity and ovality to ±0·002in.

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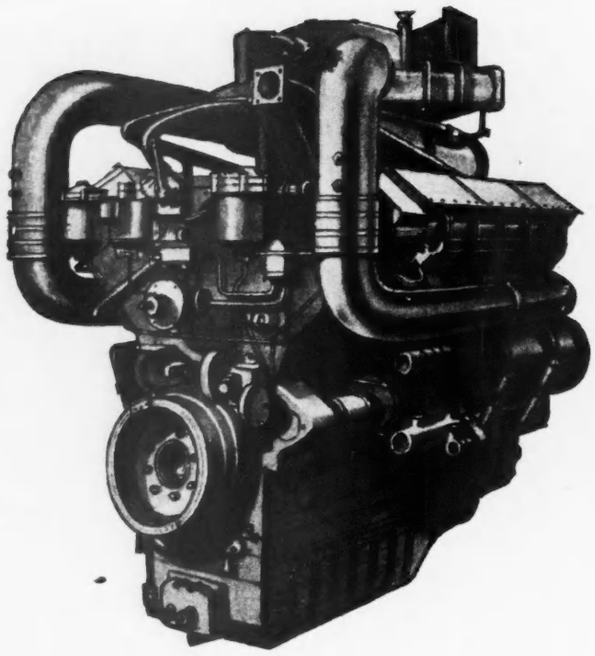

Typical of the MD range of engines is this Type 650 12 cylinder supercharged model with cylinders arranged in 'V' formation.

◀ Railway Traction 220-2,000 B.H.P.

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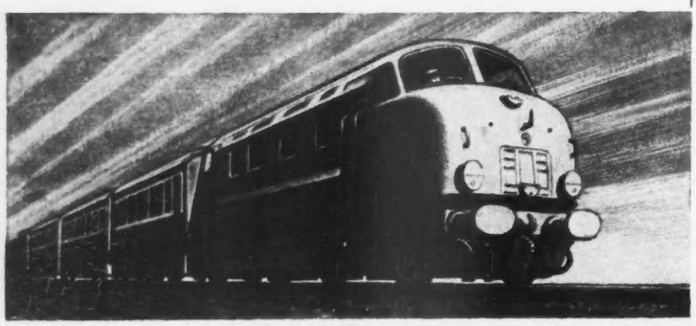

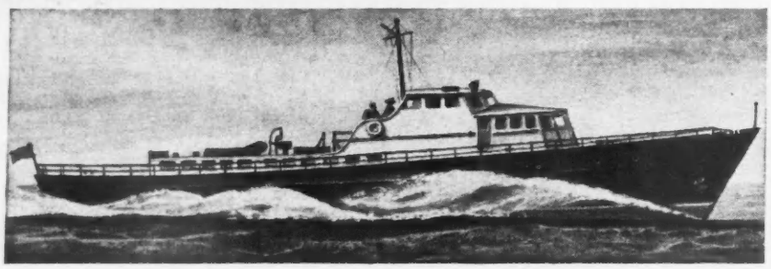

Bristol Siddeley have the exclusive manufacturing and selling licence in the United Kingdom for the world-famous Maybach MD range of In-line and 'V' form diesel engines. These diesels range from 4-cylinder engines of 220 hp to 16-cylinder engines of 3,000 hp. They have an outstanding record of performance and reliability over millions of miles on railways throughout the world, and are widely used for marine propulsion and industrial power generation of all kinds.

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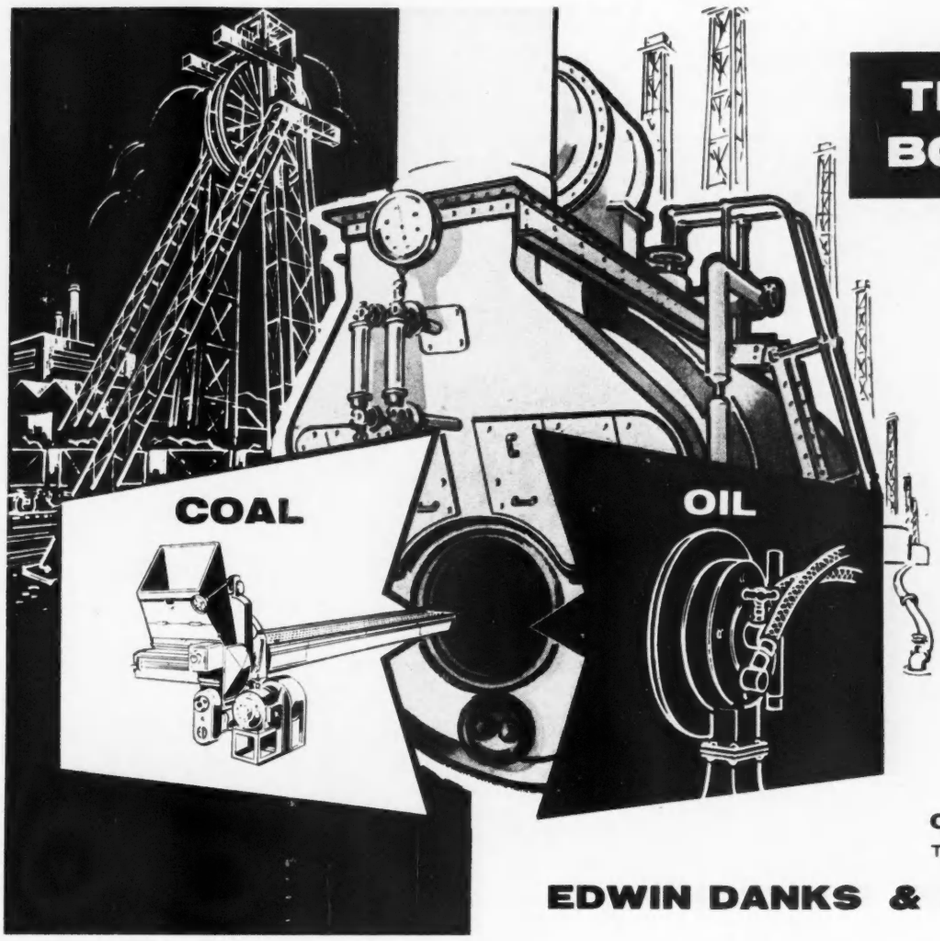

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MOTOR PRESSINGS
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The Nitriding Process for Case-hardening Special Steels by Nitrogen offers

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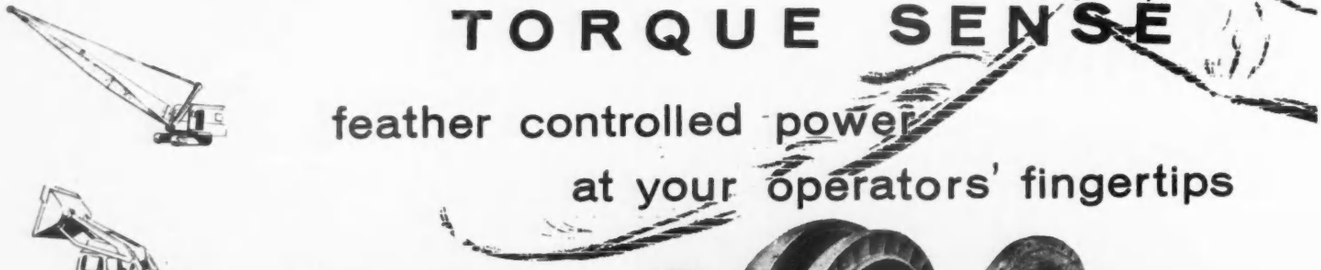

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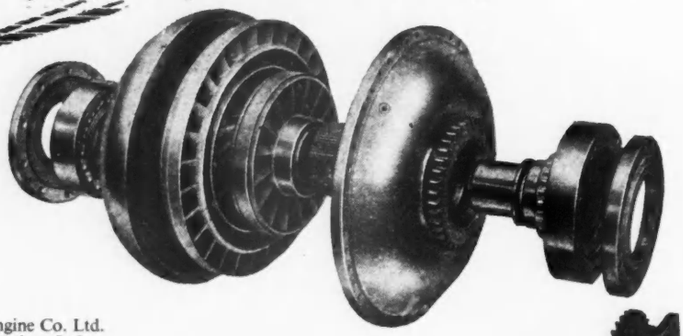

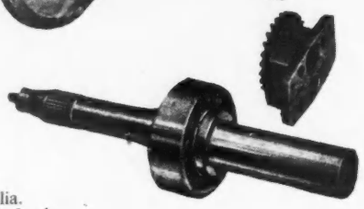

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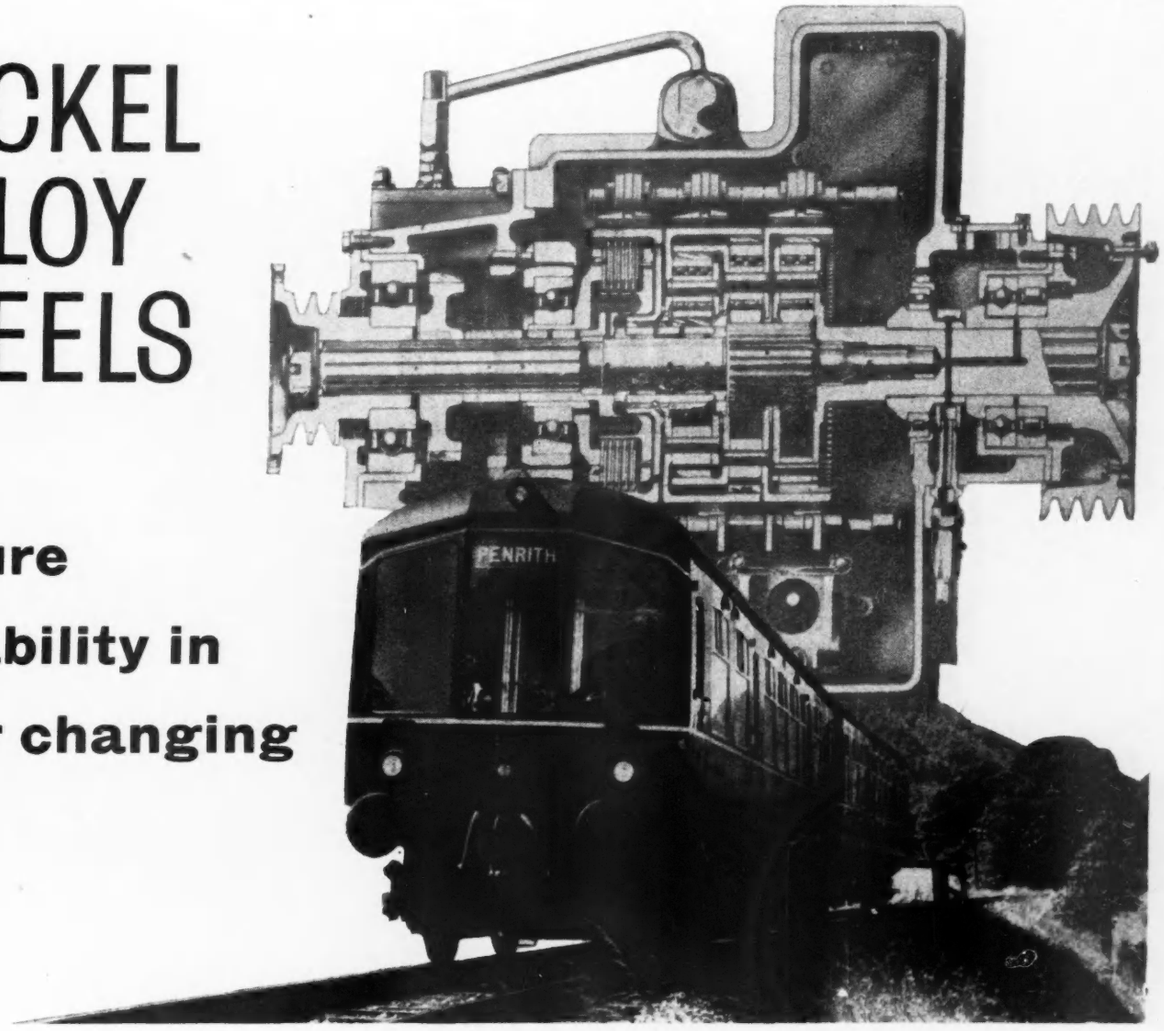
NICKEL ALLOY STEELS

ensure reliability in gear changing



The self-changing gear box, produced by Self-Changing Gears Ltd., Coventry, is standard on road, rail and water transport in many lands, and notably on London's buses.

This famous unit, in both its pre-selector and fully automatic versions, incorporates a range of nickel alloy steels. Although there is no direct mechanical operation of the gears in the normal way, heavy train, truck and bus operation inevitably imposes severe stresses upon the gears and to withstand these stresses most of the operating mechanism in the 'Wilson' box is made from nickel alloy steels, including the 3 per cent nickel-chromium-molybdenum EN 36 case-hardening steel.

TYPICAL CORE MECHANICAL PROPERTIES OF

EN36

SIZE	HEAT TREATMENT	MAXIMUM STRESS t.s.i.	ELONGATION per cent	IZOD ft. lb.
$1\frac{1}{8}$" dia.	Oil quenched 780°C.	72·0	19	69
$2\frac{1}{8}$" dia.	Oil quenched 860°C.	62·7	19	67
	Oil quenched 780°C.			
3" dia.	Oil quenched 860°C.	59·7	22	72
	Oil quenched 780°C.			

The benefits to be gained from the more highly alloyed case-hardening nickel steels, such as EN 33, EN 34, EN 36 and EN 39 include ease of heat-treatment, minimisation of processing distortion, and general reliability.

Send for 'The Mechanical Properties of Nickel Alloy Steels' ▶

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TGA 21/2R

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★ *PRIMER 'X' has proved its effectiveness and durability under controlled field tests.*

★ *Saves money and time in ensuring against paint failure.*

★ *The ideal Primer for all maintenance work.*

★ *Invaluable for Housing Scheme Work, Schools, Public Buildings, etc.*

SUPPLIED IN PINK AND GREY · APPLY BY BRUSH

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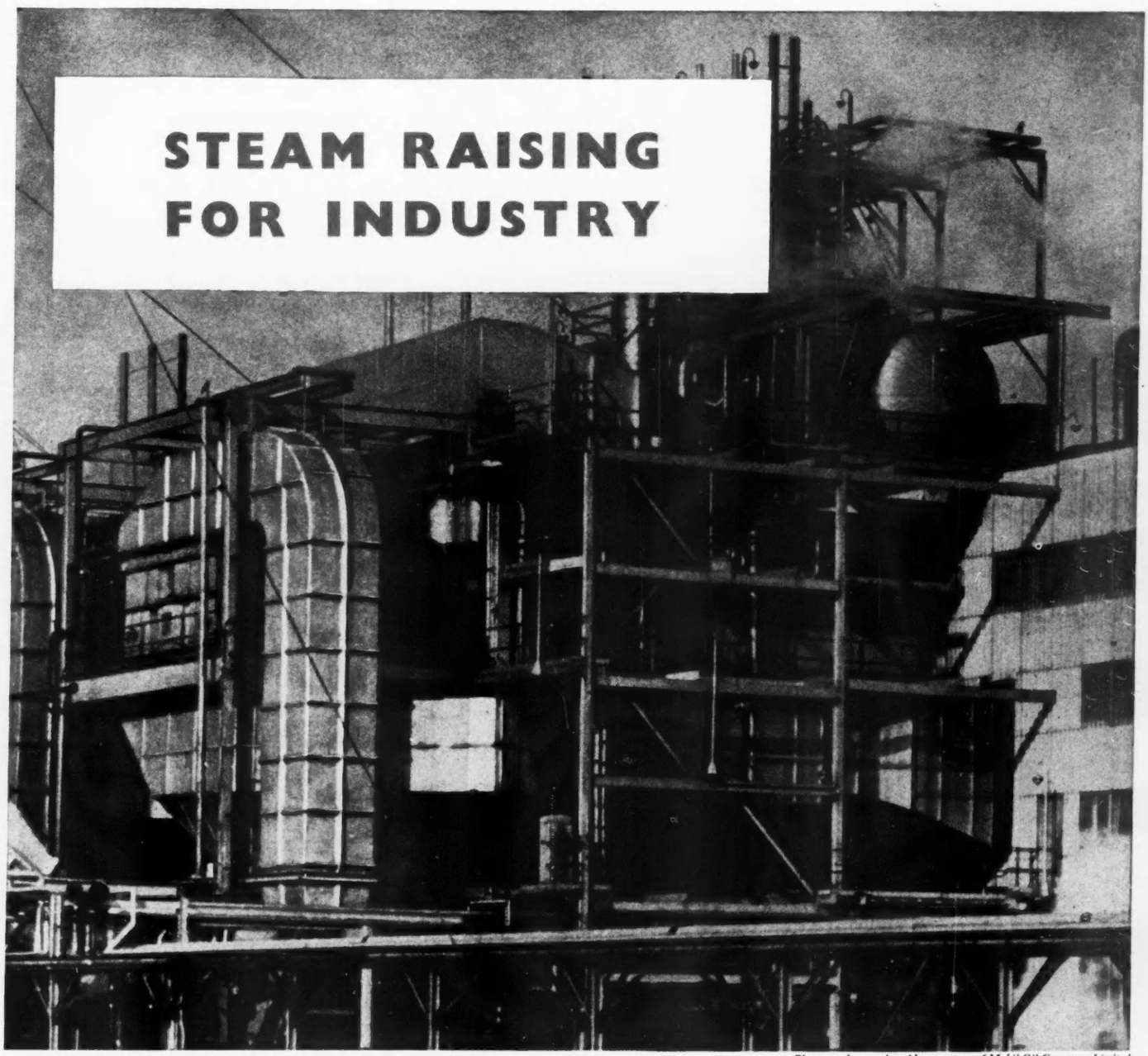

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3 boiler units each producing 180,000 lbs/hr. at 615 p.s.i. 750°F.

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IB 14

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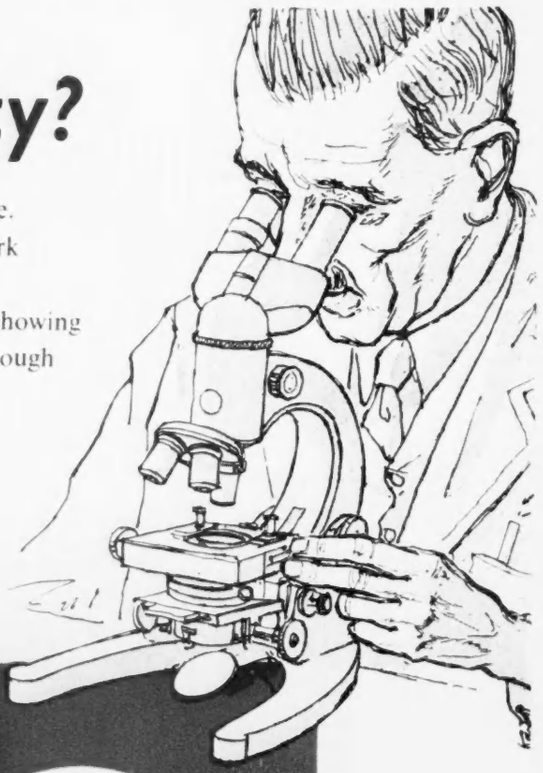
What is filter *Stability?*

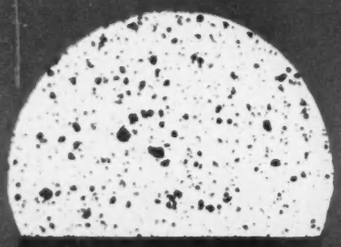
A filter should do its work with equal efficiency throughout its working life. It should be *stable*. The C.A.V. paper element fuel filter continues to work efficiently right up until it is finally choked.

Many filters on the market do not, however. On test, they may start by showing a fair efficiency, but later more and more of the abrasive particles pass through the filter material. Such unstable filters are quite useless, and are no safeguard to your fuel injection equipment whatsoever.

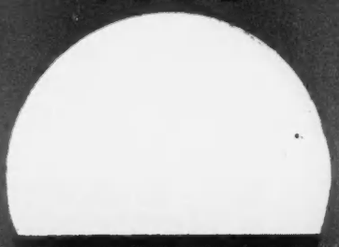
These photomicrographs of fuel tell the story of actual tests.



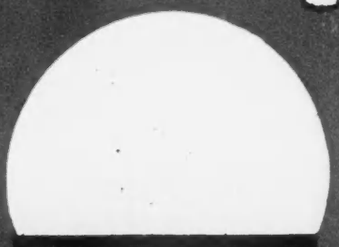
STABLE



1 Fuel laden with abrasive dust, before filtration

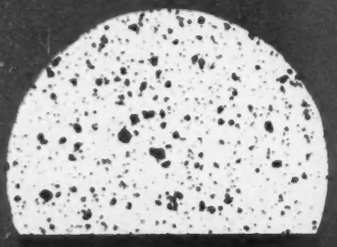


2 The same fuel after passing through a C.A.V. paper element filter at beginning of test



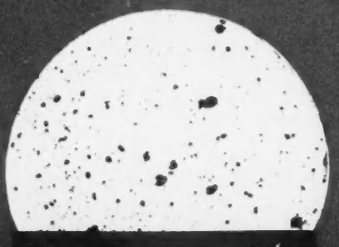
3 Fuel after filtration by the same element when all but choked by waxy sludge and dirt

UNSTABLE *and Valueless*



4 The same fuel is used for this test

5 At the beginning of test, filtration is fairly efficient



6 After the filter element is partly choked, the fuel passing through takes with it nearly all the particles of dust

There is only one genuine C.A.V. paper filter element. Substitutes are frequently unstable

TO BE SAFE, USE GENUINE C.A.V. REPLACEMENTS

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The World's Leading Manufacturers of

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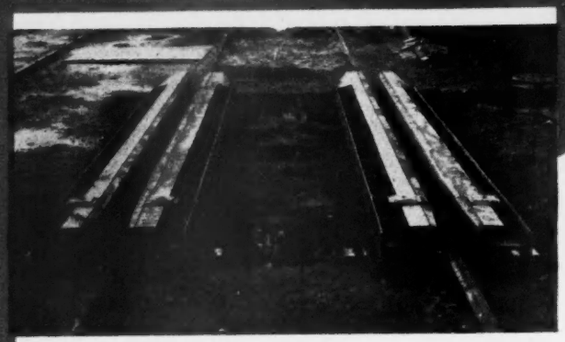

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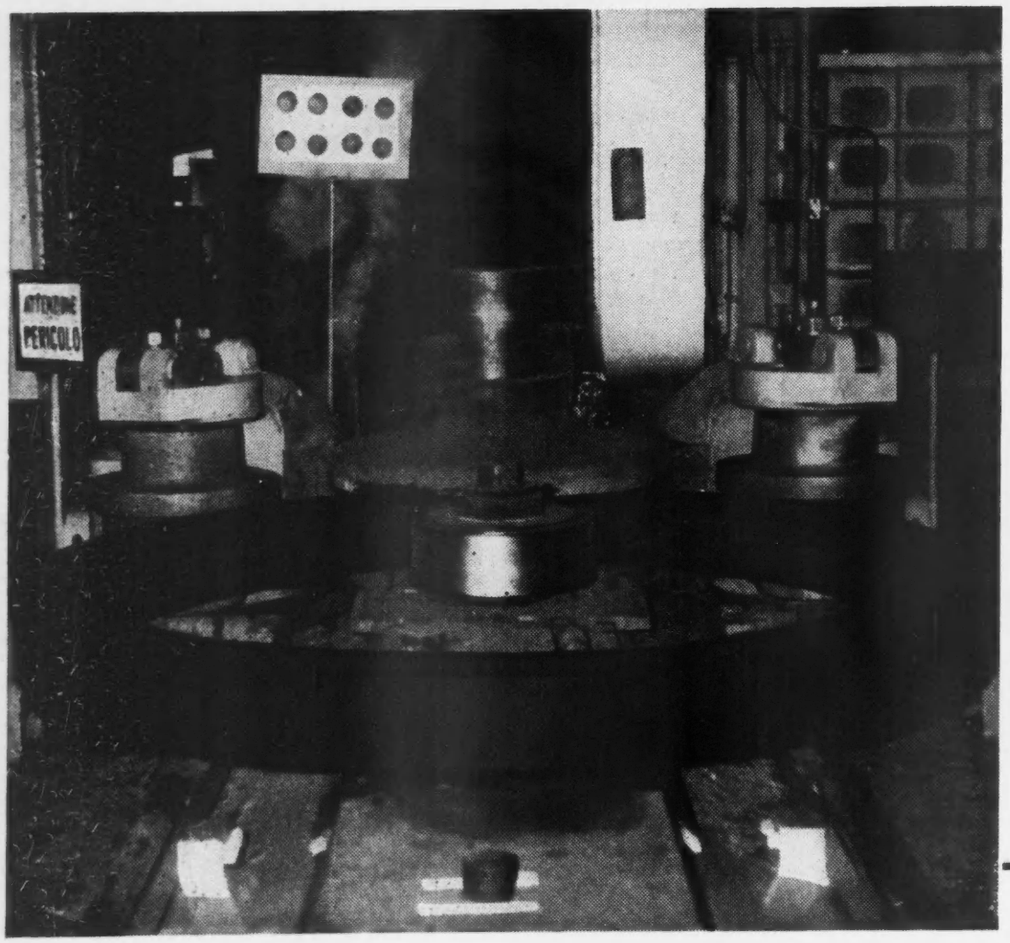

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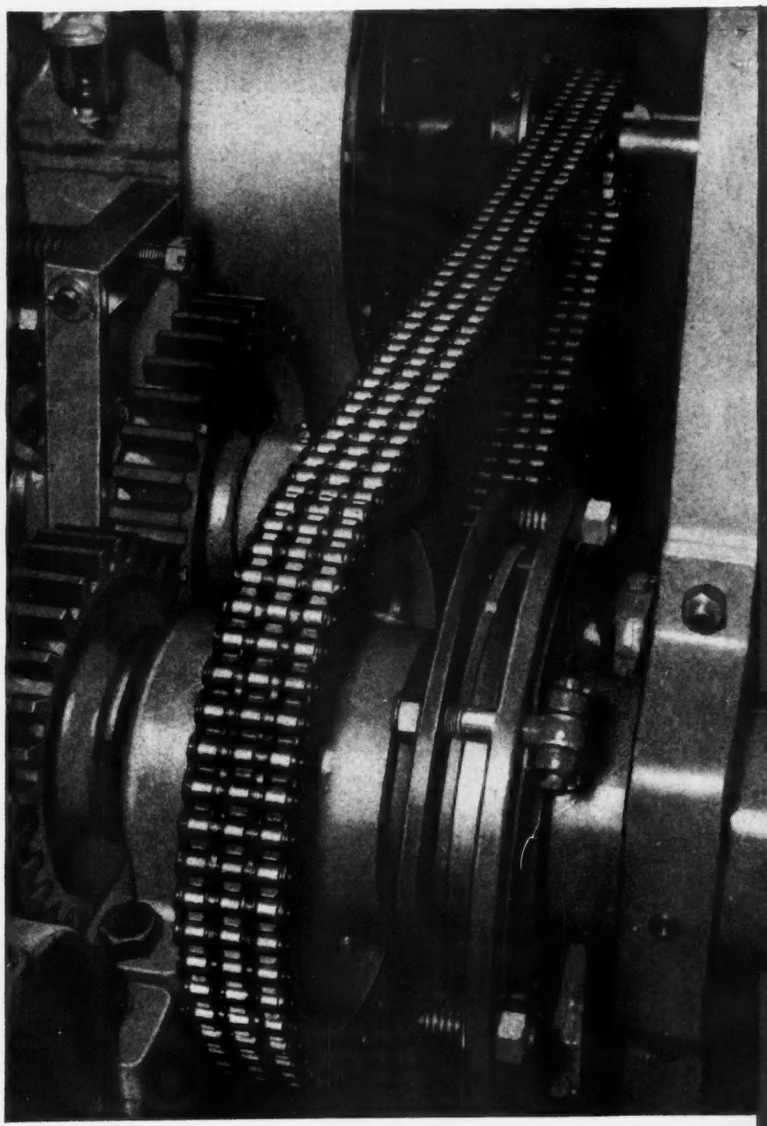

Illustrated is the main drive from power unit to power take off by a PERRY No. 34612 ¾" pitch × .460" wide triplex roller chain on the Jones K.L. 44 Mobile Crane. Photograph by courtesy of Messrs. K. & L. Steelfounders Limited.

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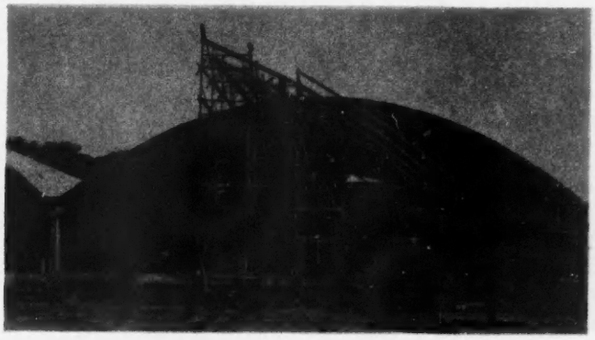

Leggat's achieve a 7 day 'pour and strike' cycle for each 3 span 25 foot section of these Ctesiphon Warehouse roofs at Paisley.

These pictures show the construction of two warehouses each with 3 roof spans of 100ft. for Messrs. Chivas Brothers Ltd., Scotch Whisky Distillers and Exporters, at Paisley by Messrs. Hugh Leggat Ltd., of Glasgow. The roofs are of Ctesiphon Construction and consist of 2½" thick reinforced concrete corrugated arch shells each spanning the full 100ft. Each corrugation has a pitch of 8ft. 4ins. and an overall depth of 2ft. 2½ins. A pre-requisite in designing a scaffolding mobile of this character is the high degree of accuracy required; the whole arrangement working to a tolerance of ⅛".

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CREDITS

ARCHITECT — S. Lothian Barclay, M.A., A.R.I.B.A., A.R.I.A.S., Glasgow.
CONSULTING ENGINEERS — J. H. de W. Waller, D.S.O., O.B.E., M.Sc., M.I.C.E. London, and A. C. Astor, B.Sc., A.C.G.I., B.I.C., London.
CONTRACTOR — Hugh Leggat Limited, Barrhead, Glasgow. Licensees for Ctesiphon Construction.
PATENTEES FOR ROOF — Ctesiphon Construction Limited, 167 Victoria Street, London, S.W.1.

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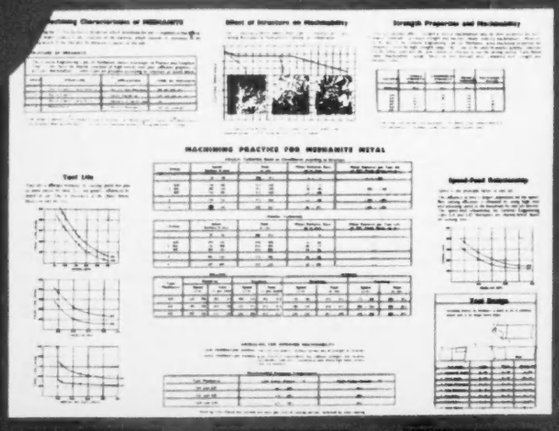

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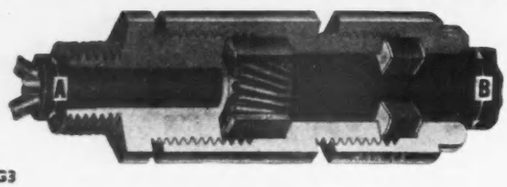
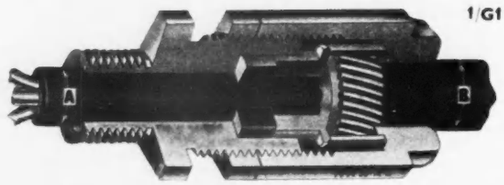


9/G3



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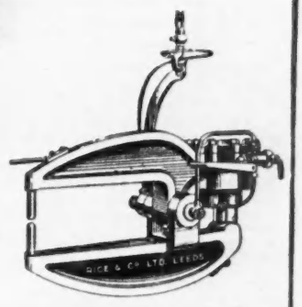

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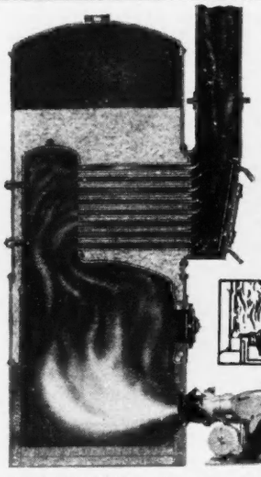

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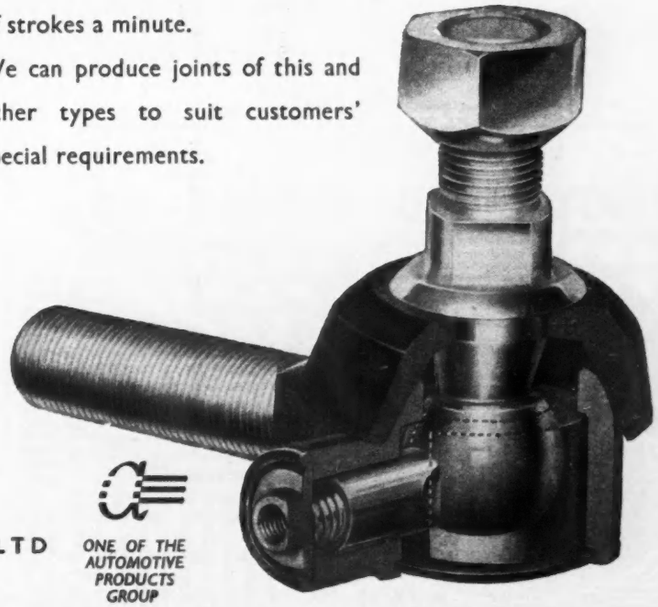

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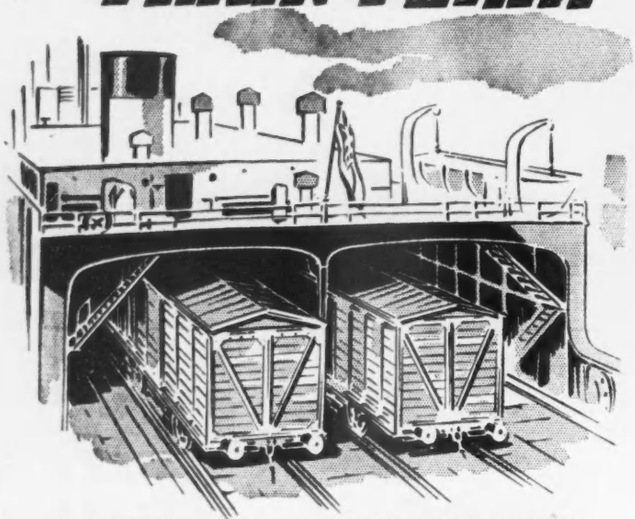

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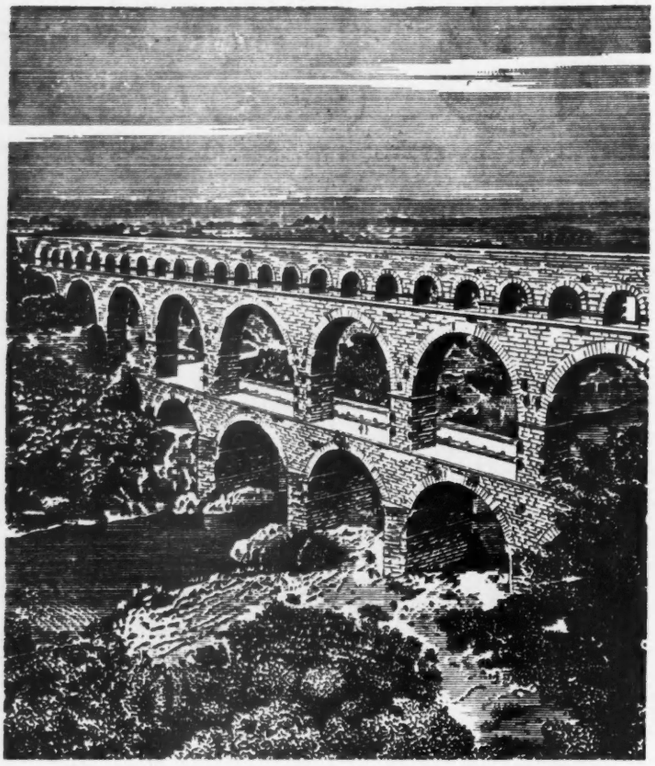

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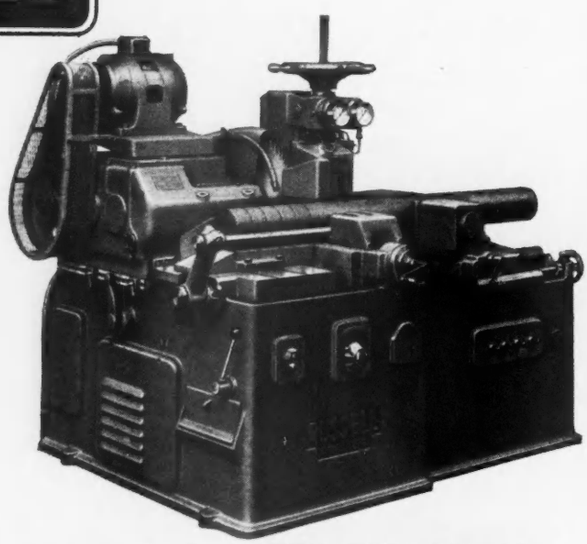

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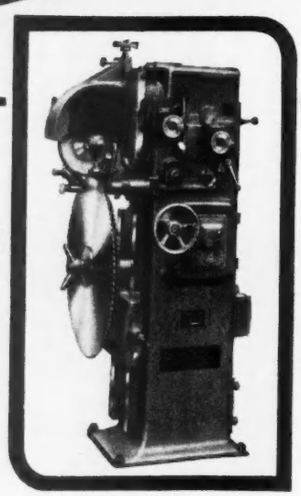

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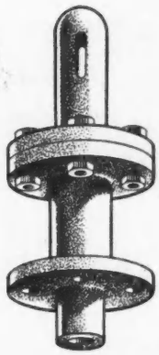

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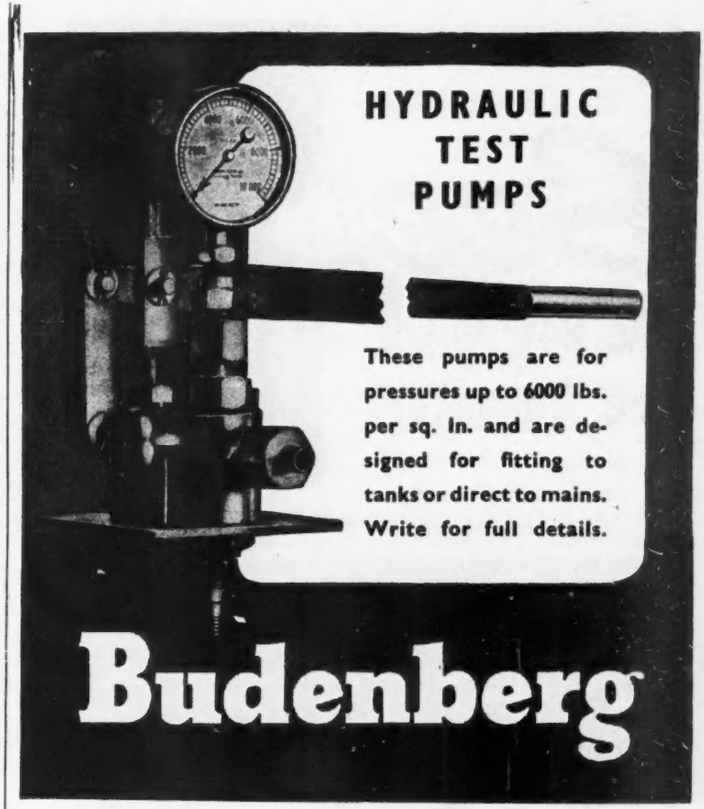
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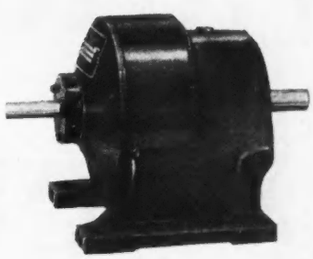

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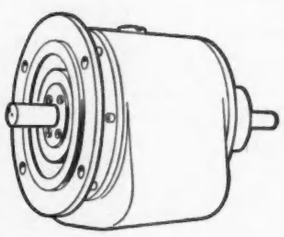

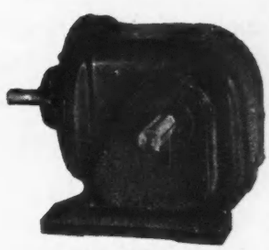

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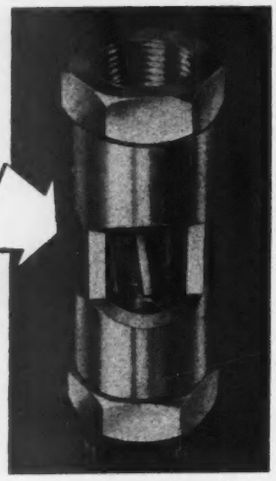

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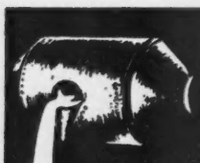

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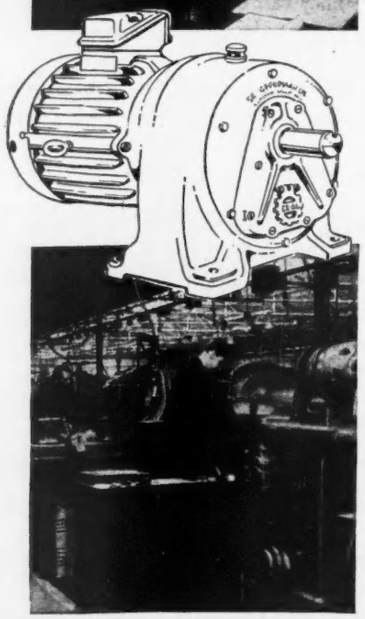

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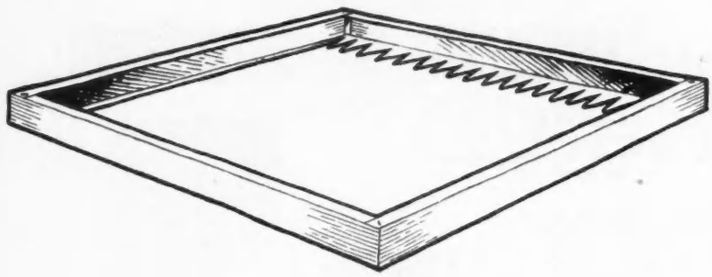

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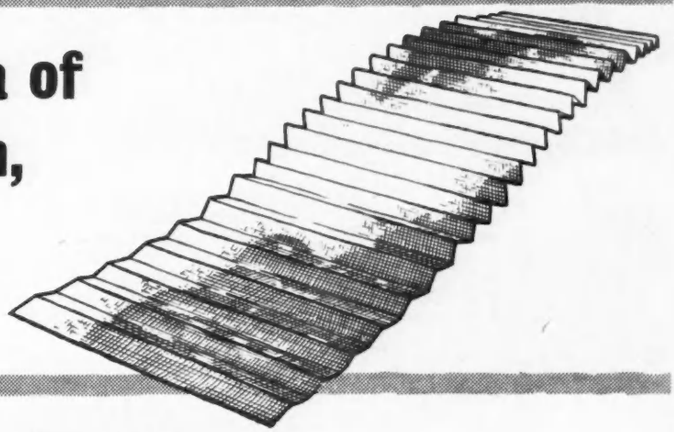
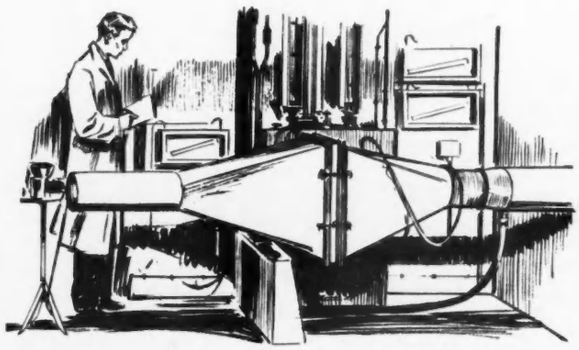
The synthetic fibrous medium is impregnated with a newly developed adhesive which adds to its efficiency and effective life. Unaffected by moisture, non-cracking, and free from fibre migration, the medium is supplied in flame-resistant form. It is pleated to present the greatest possible filter surface in the most compact space.





backed by all the resources of Vokes laboratories,

Vokes is an entirely British company and therefore tests its filters to British standards. All Vokes air filters are tested to BSS 2831 in their well-equipped laboratories, where research into new filter materials is continuously carried on.

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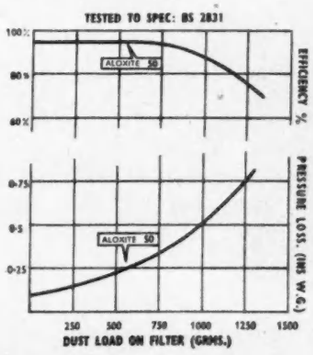
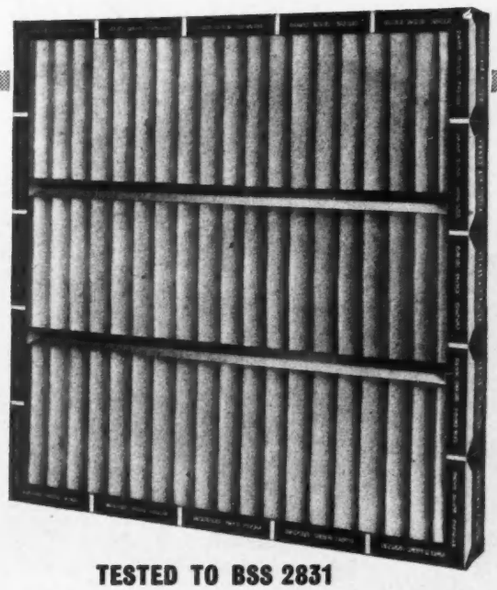
Vokes Super-Vee Air Filter with its sustained efficiency under severe industrial pollution and smog conditions is the best low cost, long life, expendable air filter for paint finishing plant, chemical laboratories, textile plant, distilleries, nuclear power plant and most heating and ventilating applications. IT IS FULLY INTERCHANGEABLE WITH OTHER SIMILAR PANELS. Comprehensive testing to BSS 2831 showed that the dust-holding capacity for a given rise in pressure loss, with no drop in efficiency, exceeds that of any other filter panel of this class. Size for size with similar filters the Super-Vee offers up to 25% greater capacity thereby considerably reducing the number of panels needed for any particular application, allowing a more compact installation *and* lower maintenance costs.





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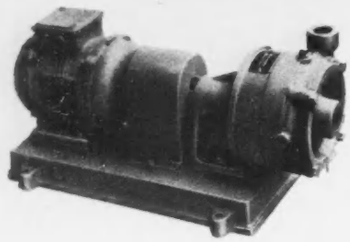

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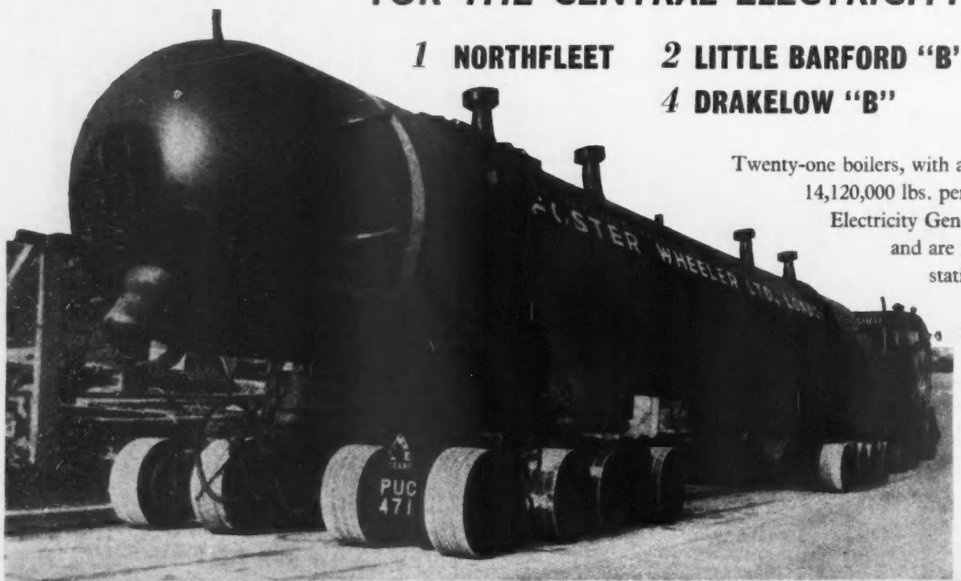

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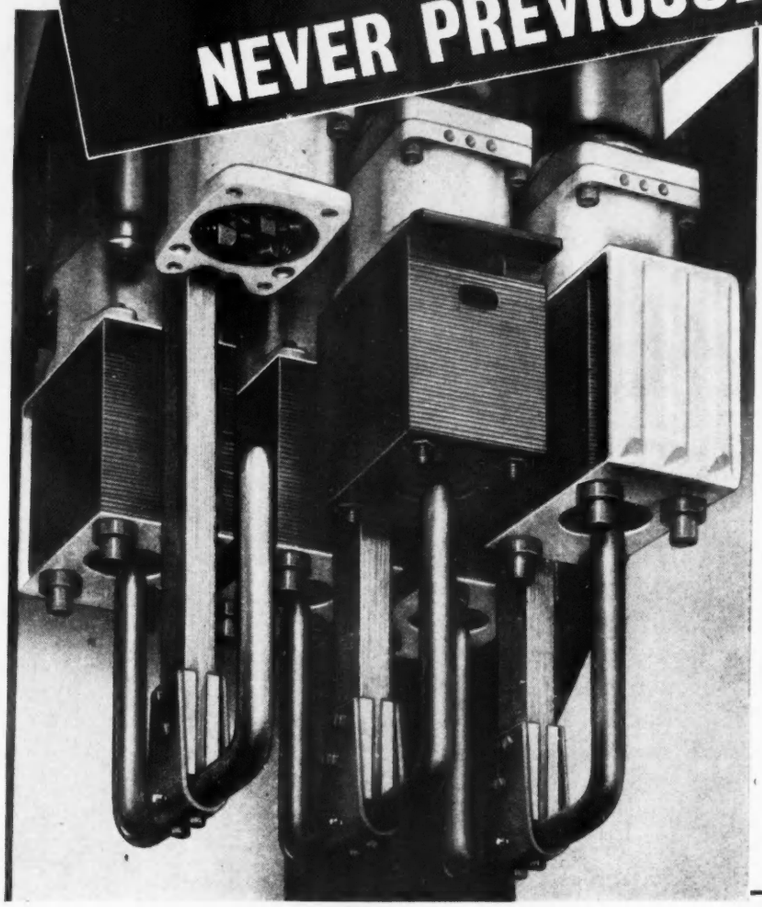

350 MVA Safety for 250 MVA 11 kV duty

The new Type PDB oil circuit-breaker is designed for use in J. & P. standard metalclad gear, which is of the size usually associated with 250 MVA, 11 kV gear, but it has been fully tested and certified for the following breaking capacities: 350 MVA at 11 kV; 250 MVA at 6.6 kV; and 150 MVA at 3.3 kV. A margin of safety greatly in excess of that previously offered, can now be enjoyed with standard metalclad switchgear **at no extra cost.**

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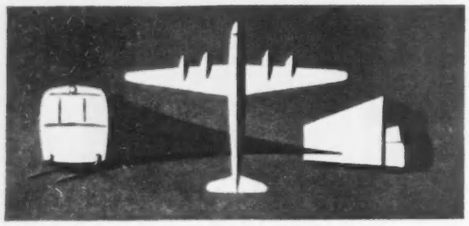

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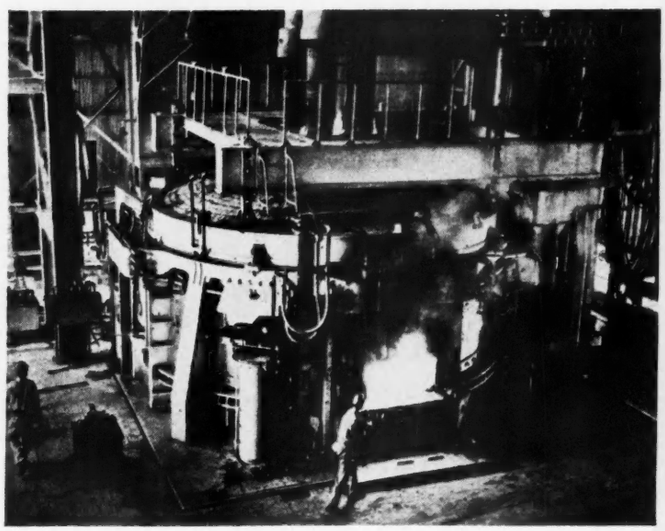

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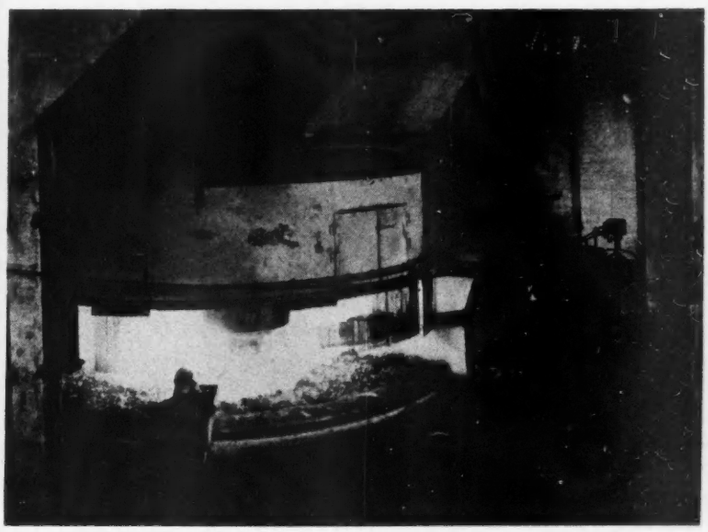

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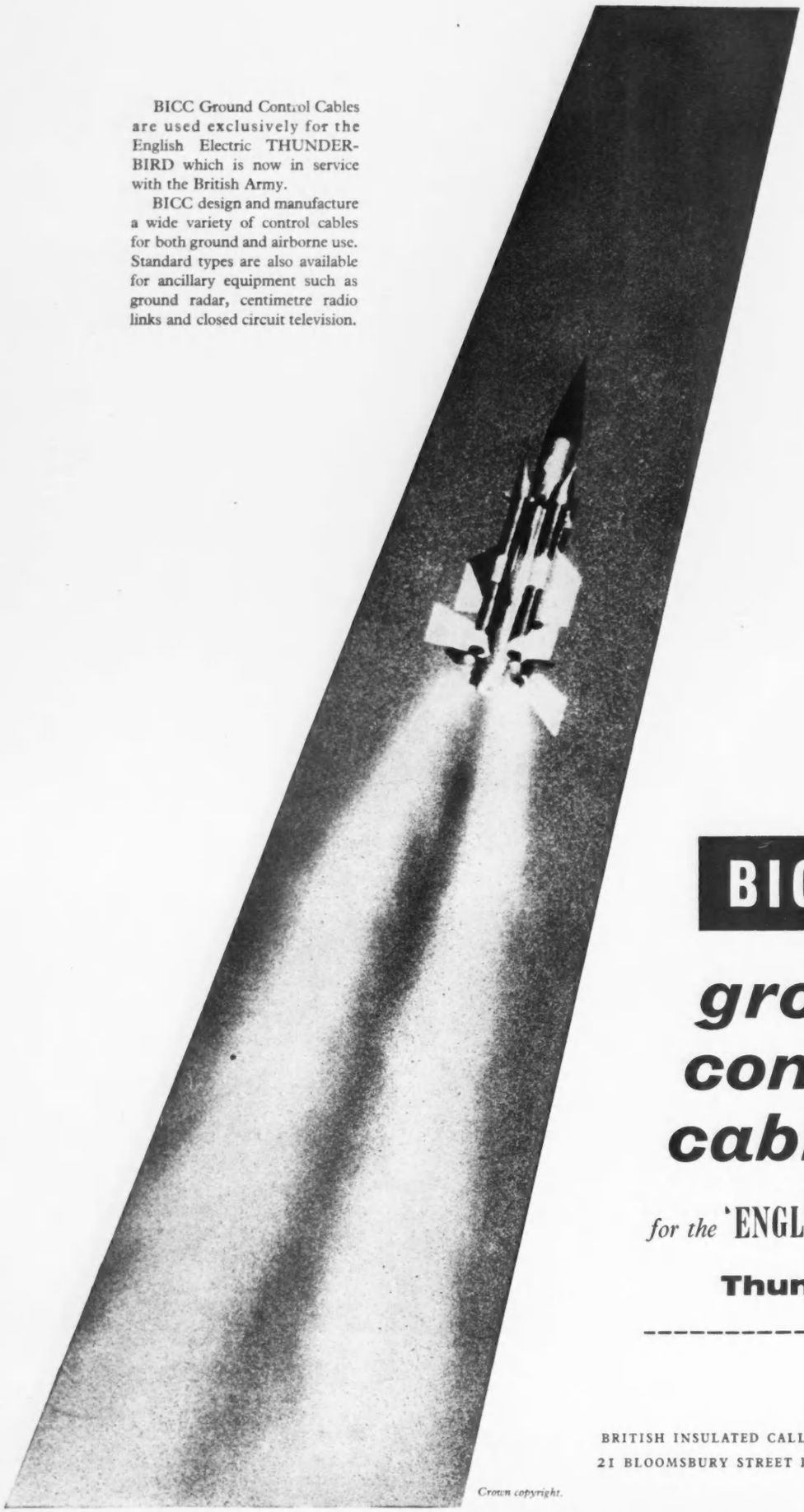

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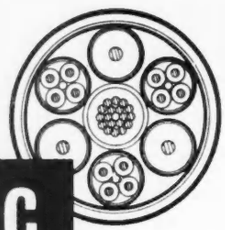

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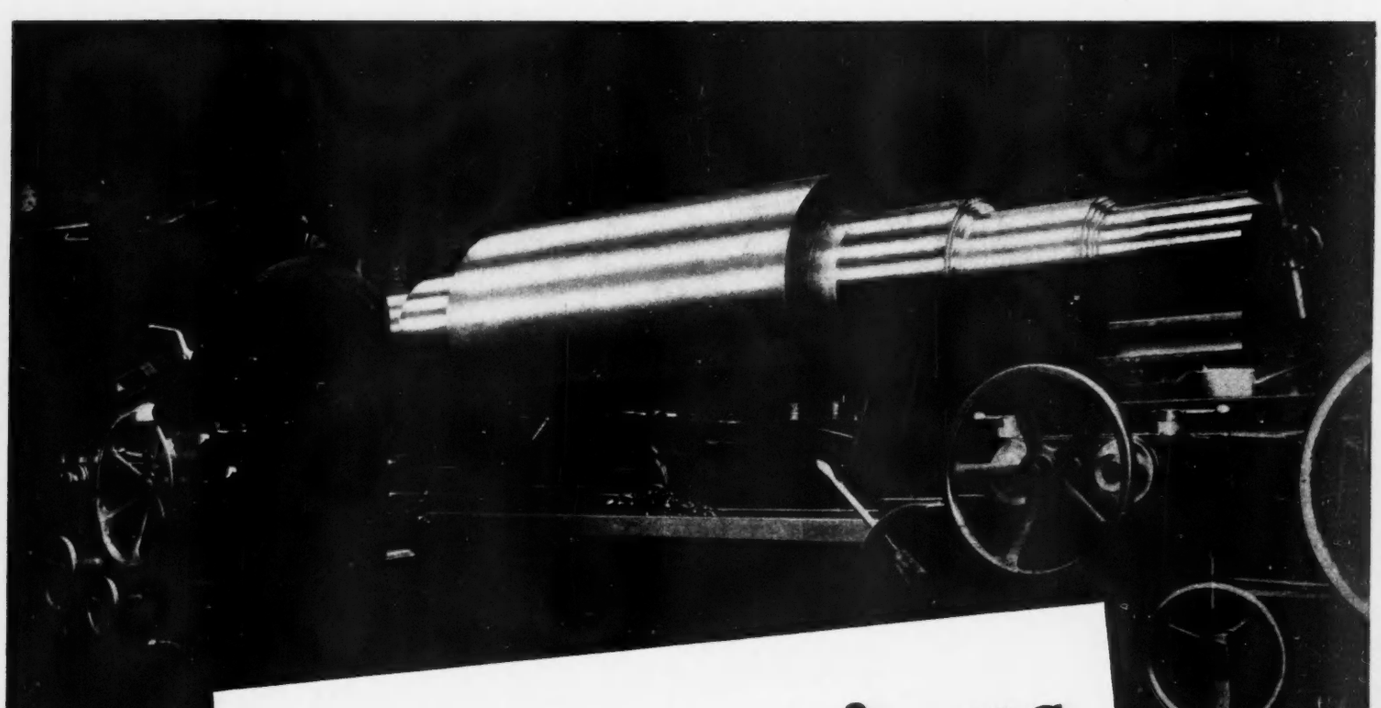

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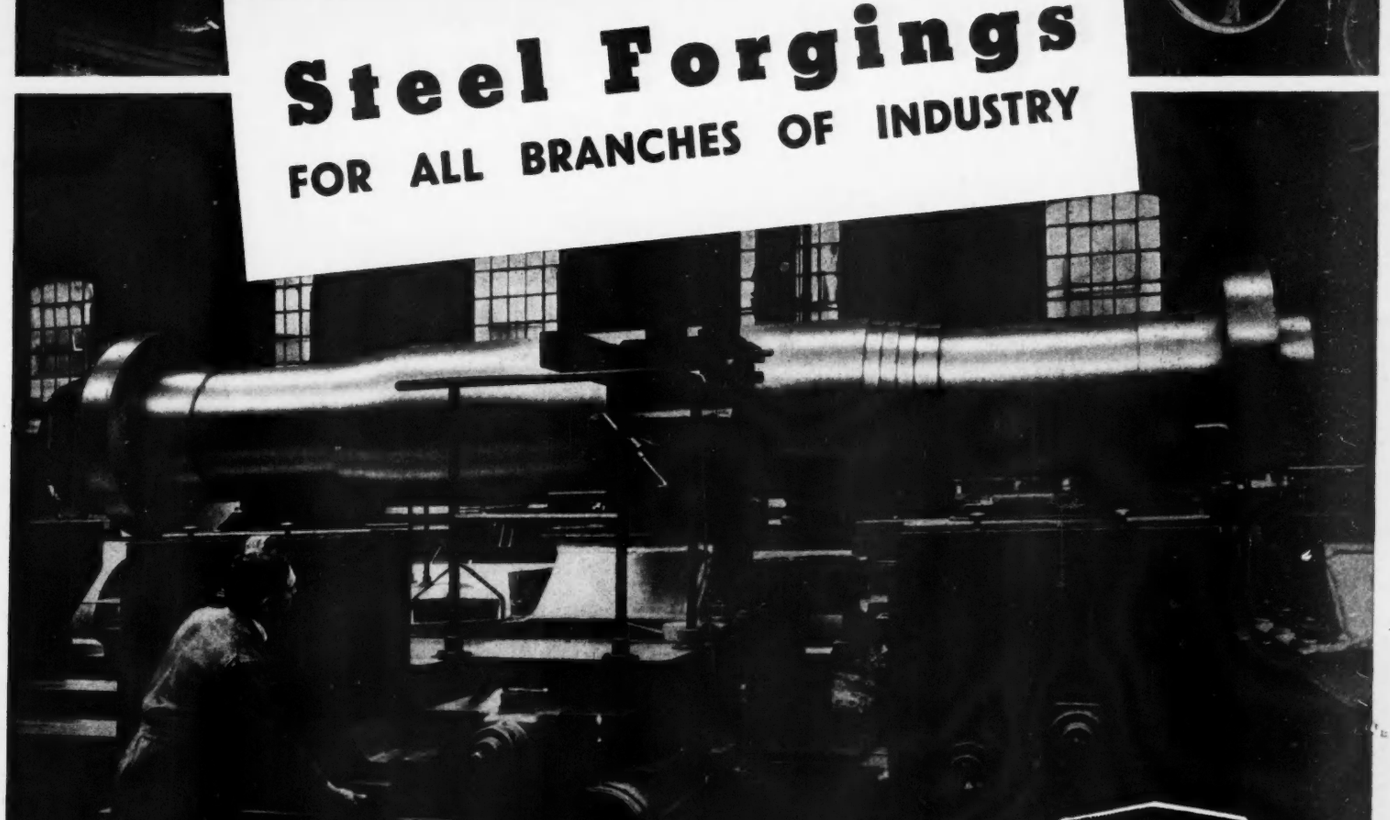

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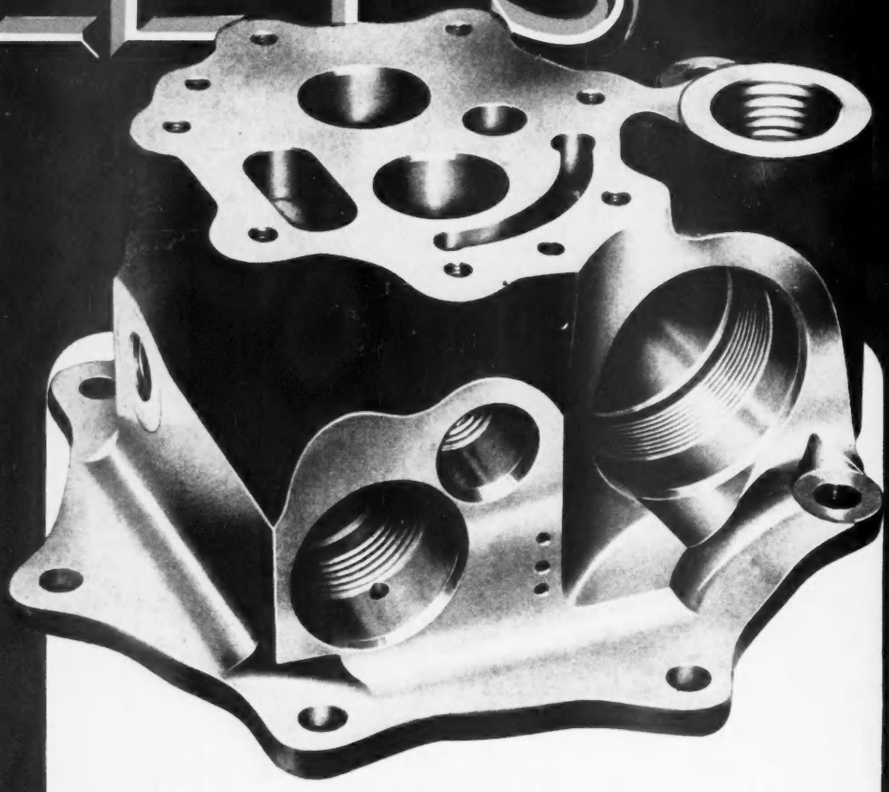

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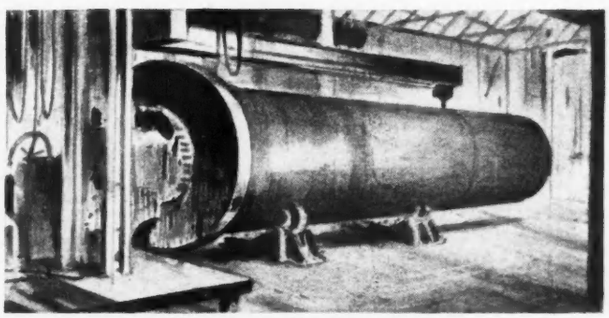

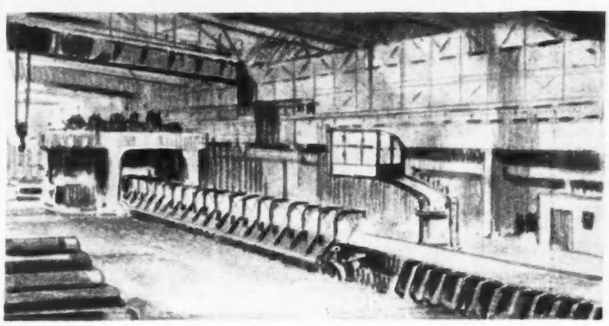

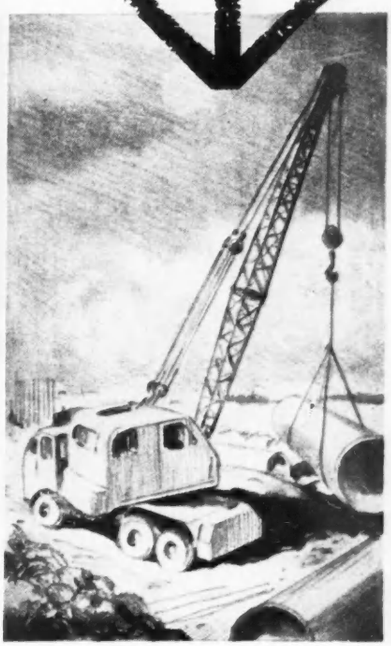

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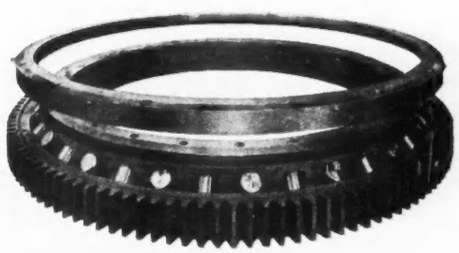

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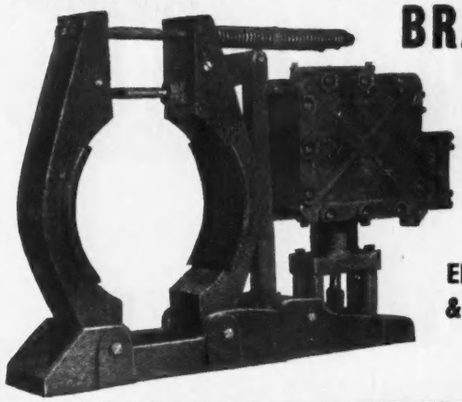

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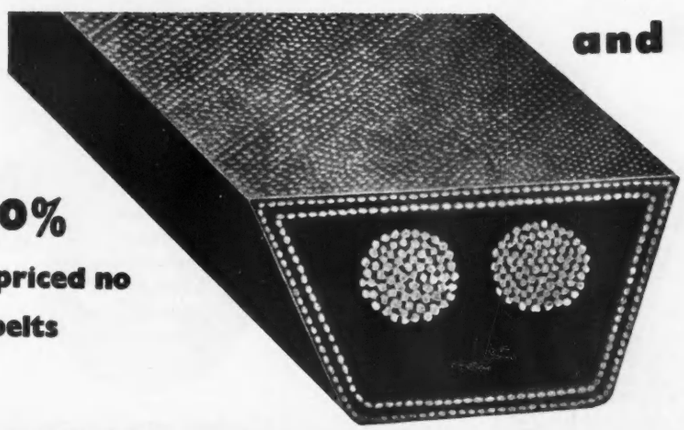

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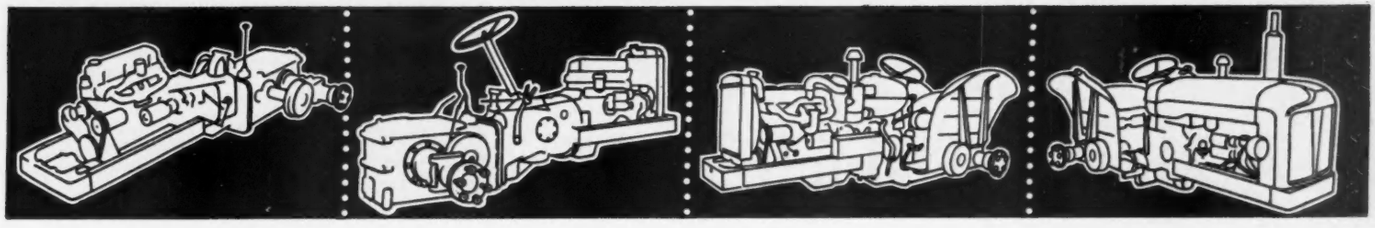

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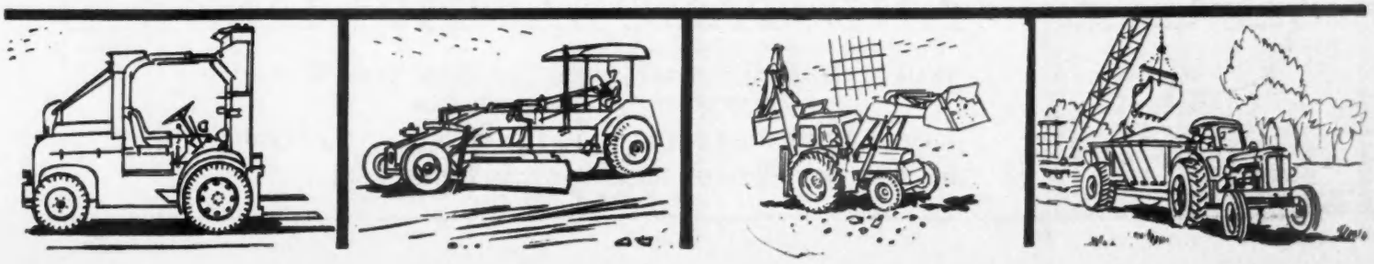

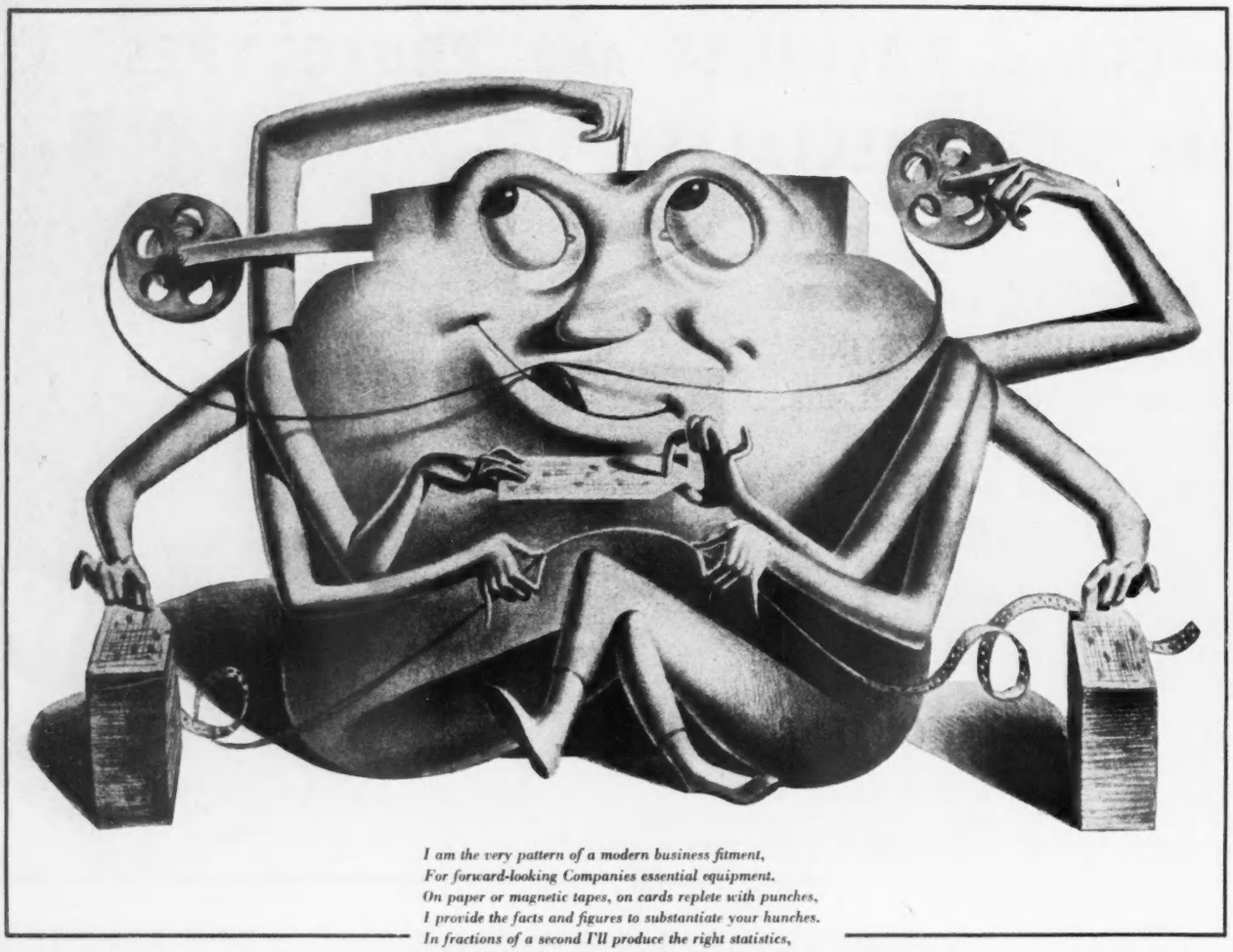

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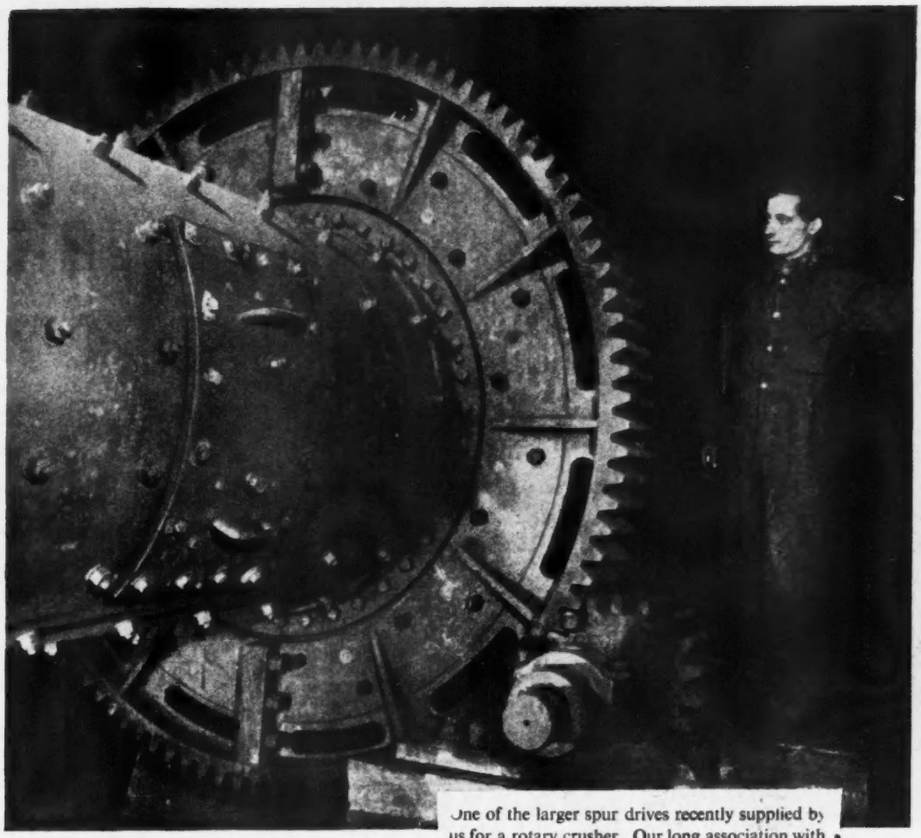

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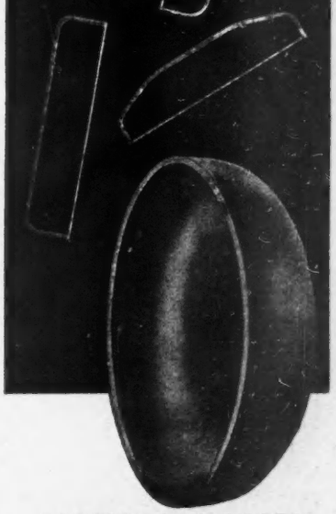

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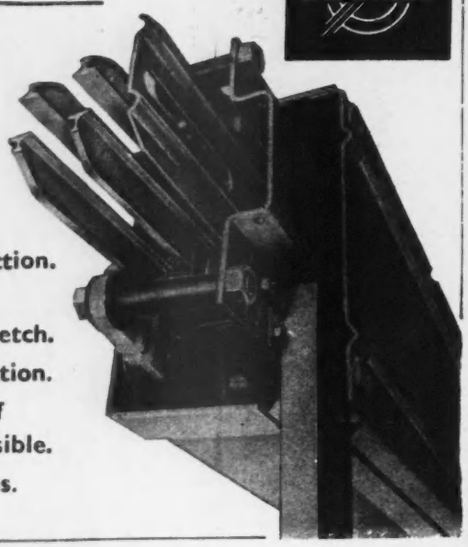

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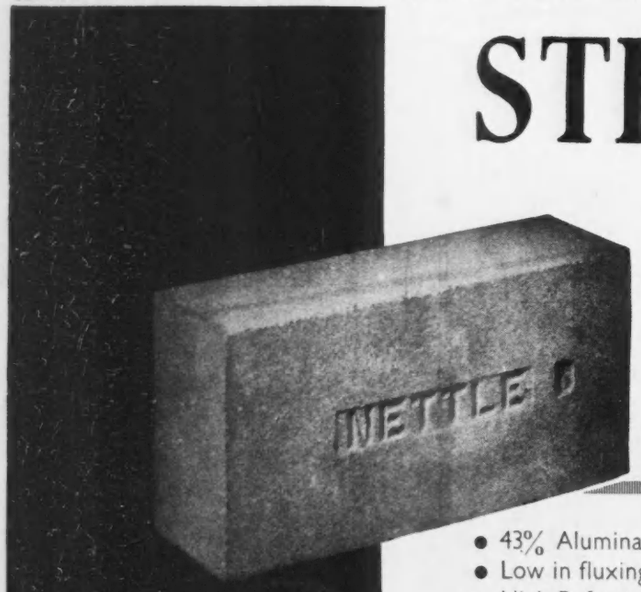

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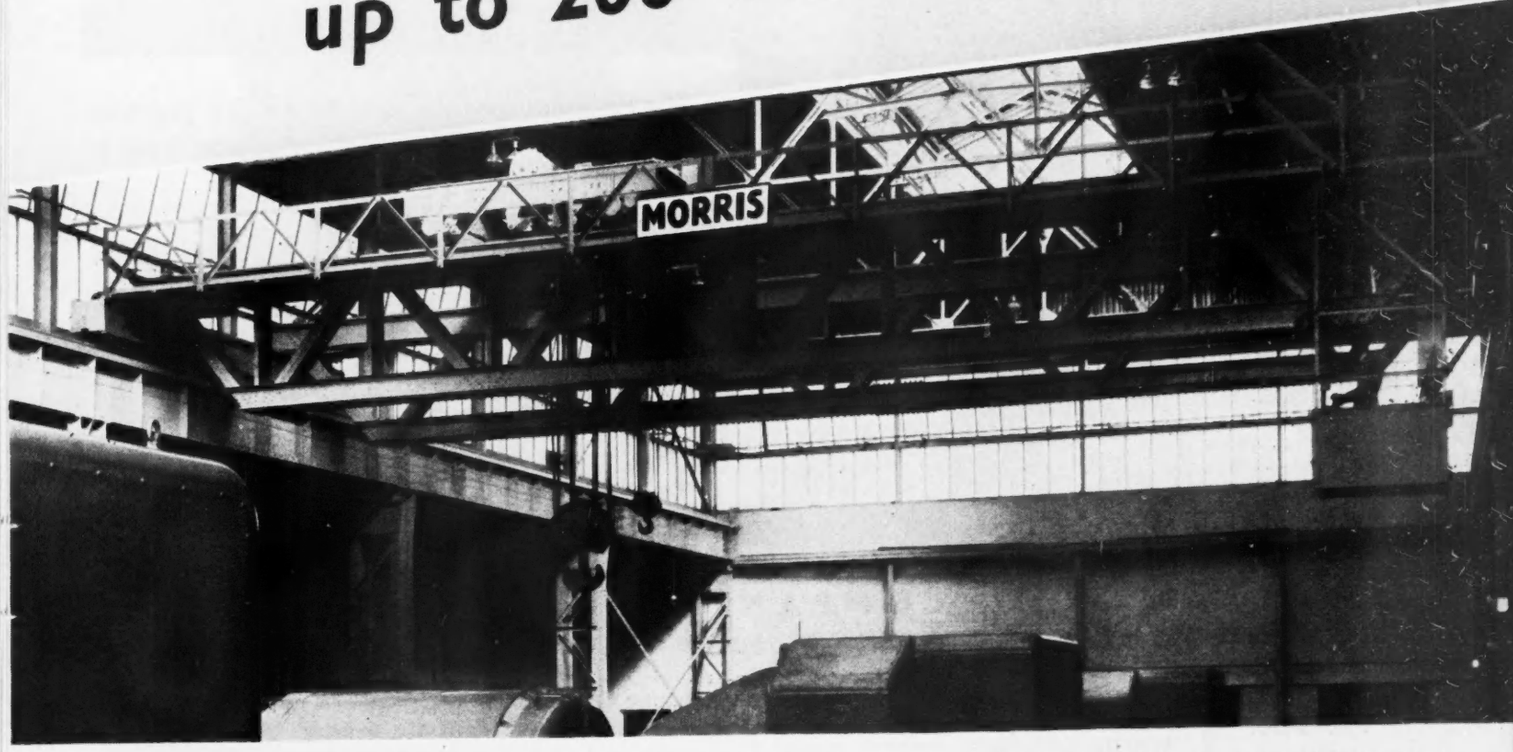

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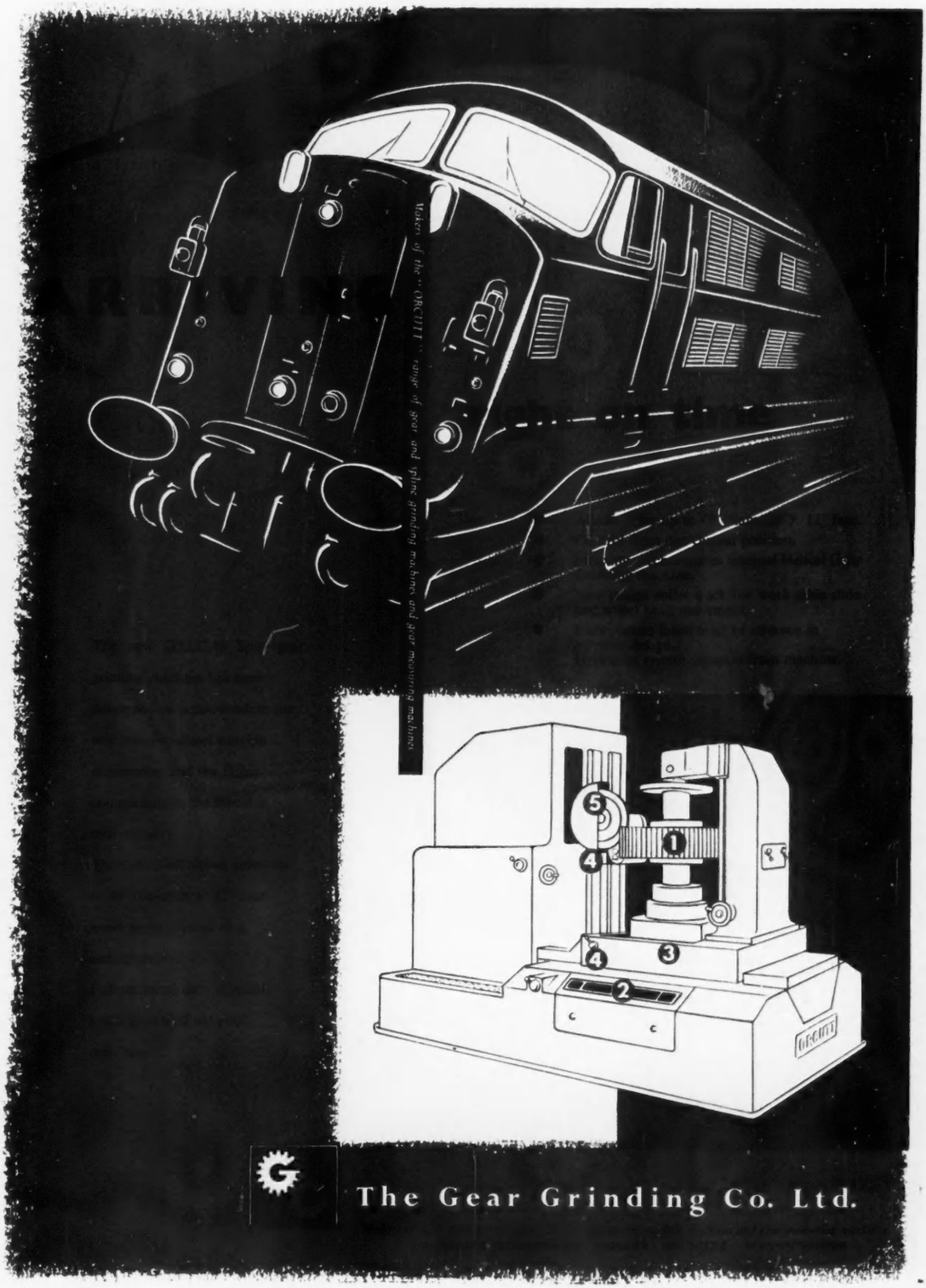
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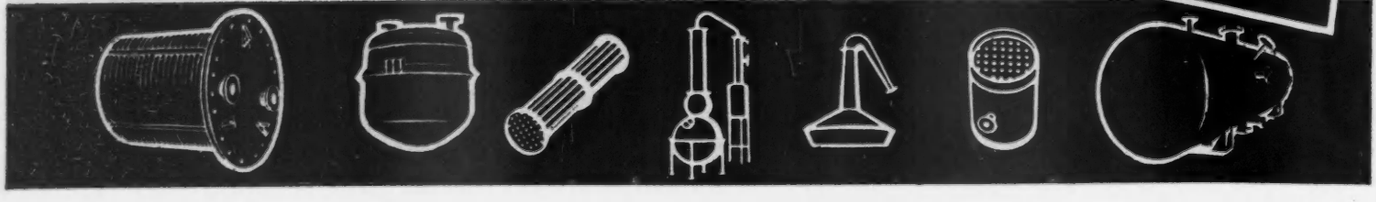

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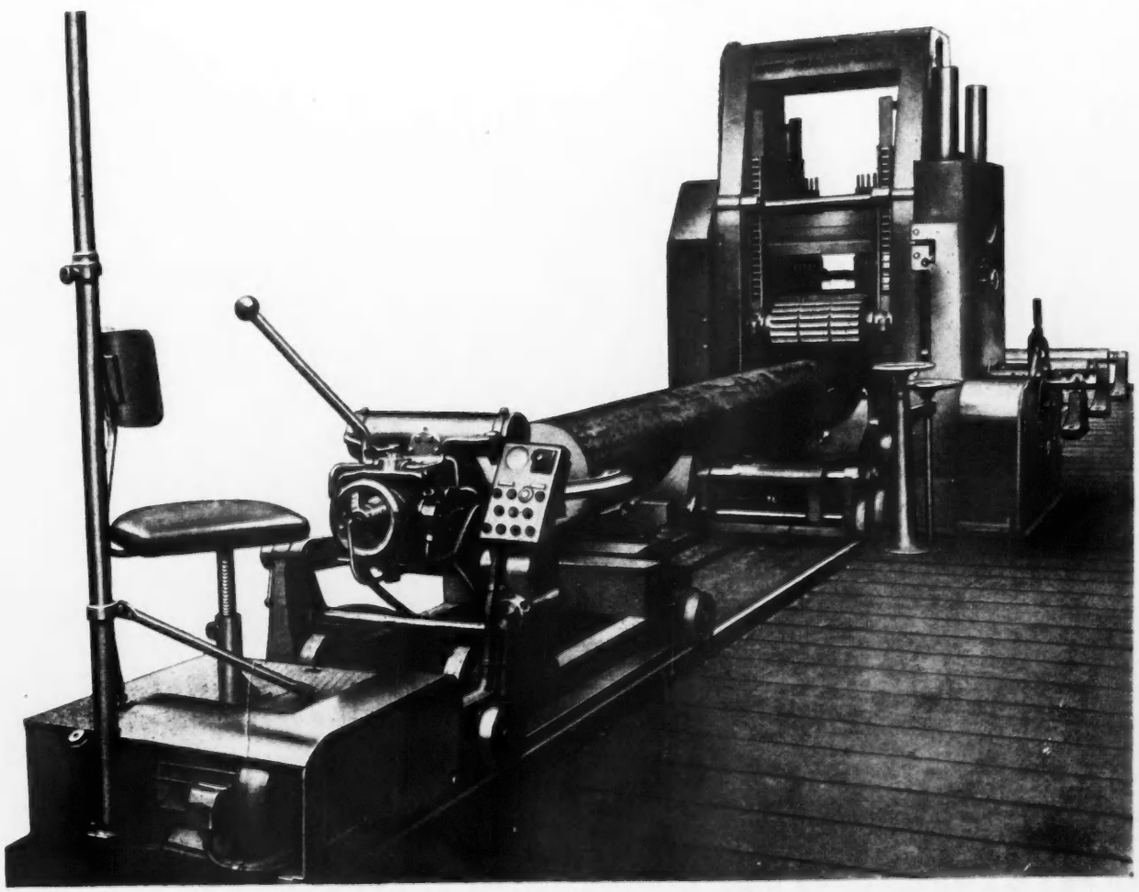

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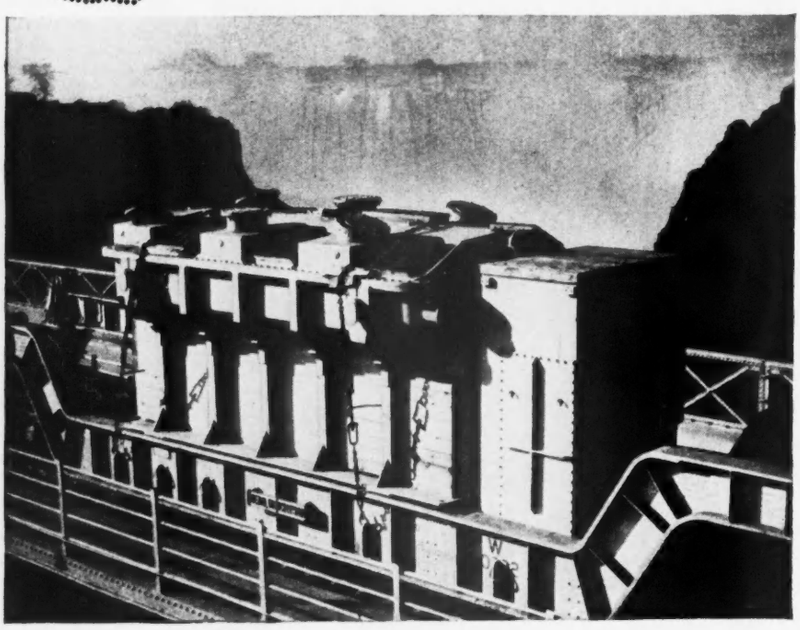
The consulting electrical and mechanical engineers are Messrs. Merz & McLellan.



A Ferranti large power transformer crossing Victoria Falls bridge on its way to the Kitwe sub-station for the Kariba Hydro-Electric scheme. Two of these transformers on special well-wagons form part of the load on a goods train. Each transformer weighs 67 tons.

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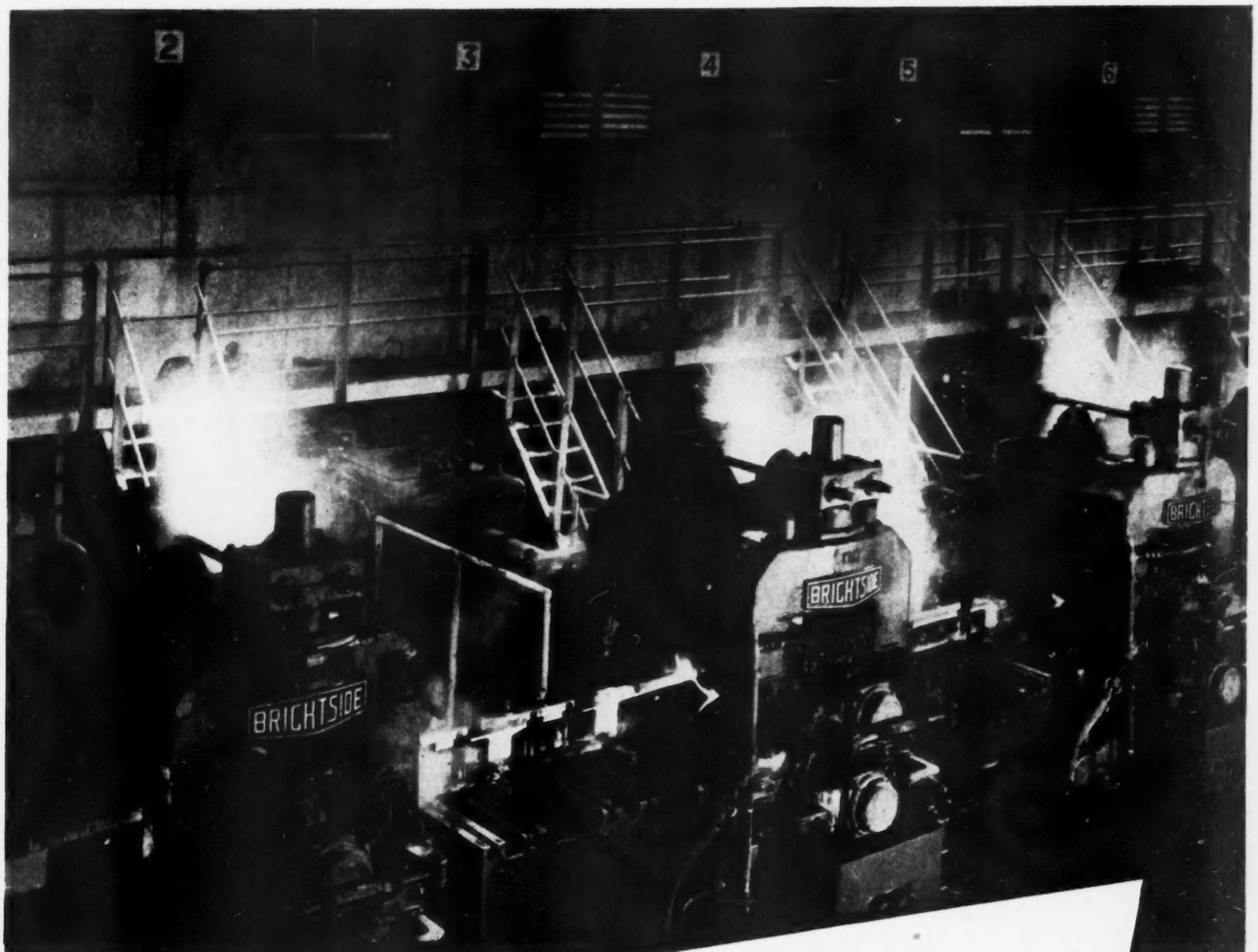

Roughing Train at Continuous Bar Mill
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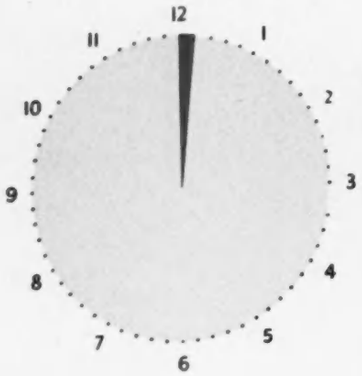

At their new fully mechanised foundry at Tipton, Bilston Foundries Ltd. are producing cast Iron baths at the rate of 60 per hour, in a wide range of styles. This output involves handling and processing a maximum of 350 tons of moulding sand per hour, all of which passes over Westwood Dawes conveyors at some stage. A total of 24 belt conveyors were designed, manufactured and installed by us on behalf of Messrs. Pneulec Ltd.

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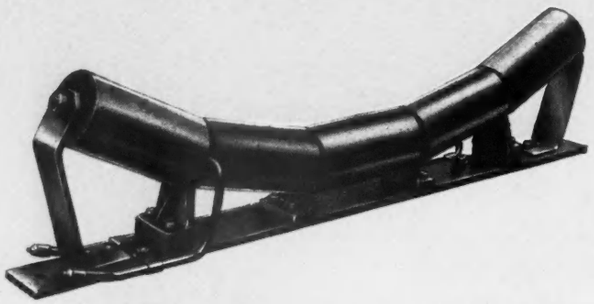

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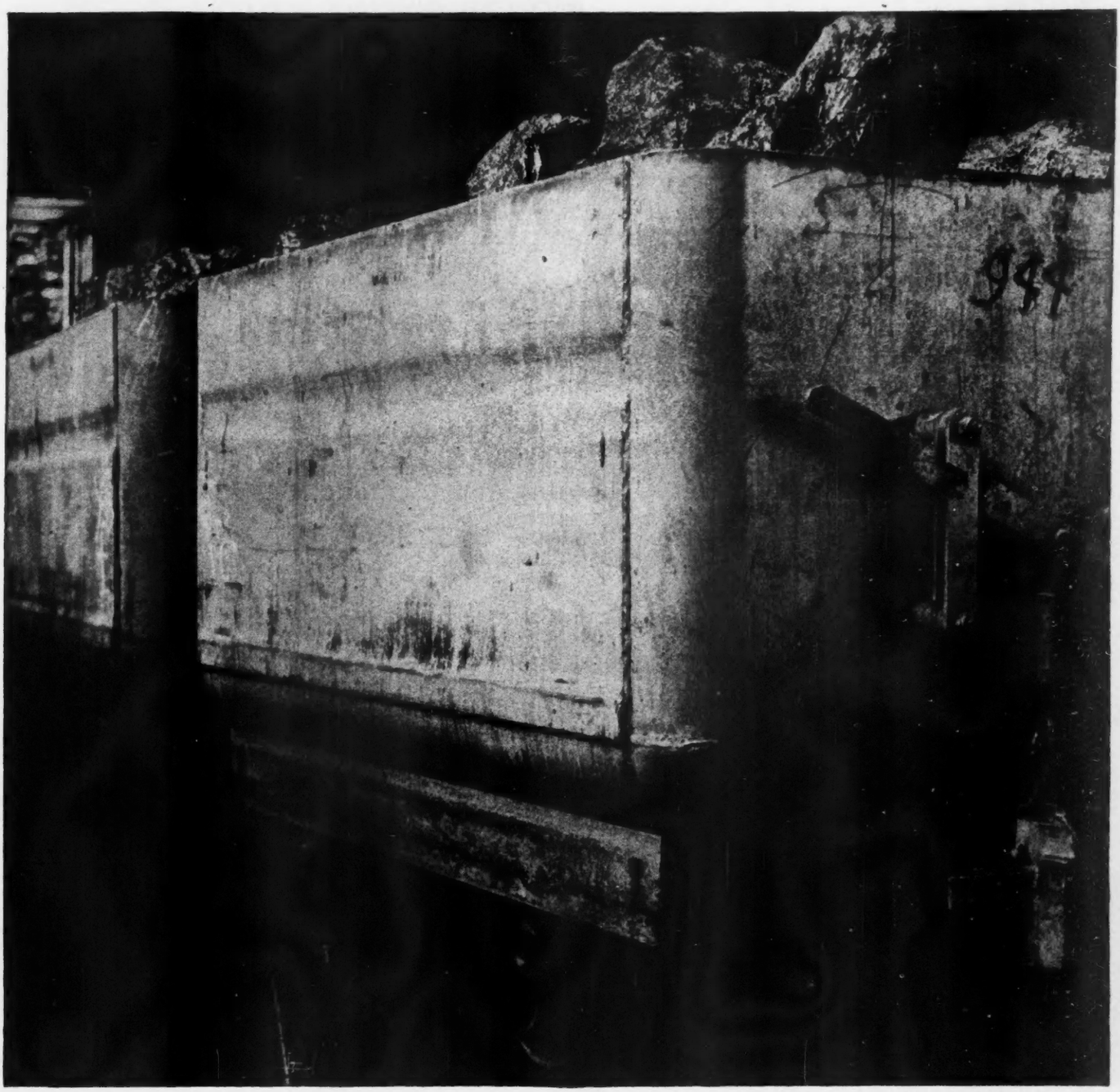

Mine cars made from SCW Cor-Ten (Photograph by courtesy of the National Coal Board)

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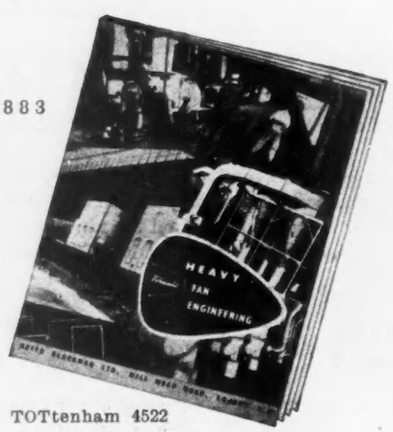

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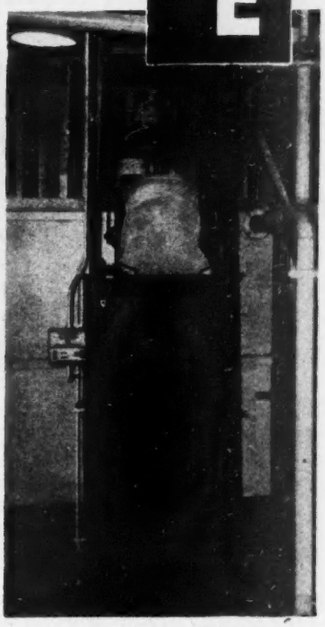

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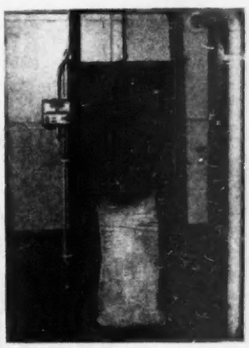

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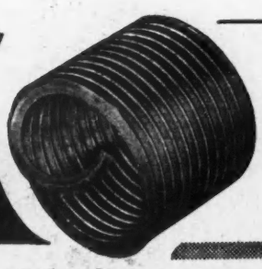

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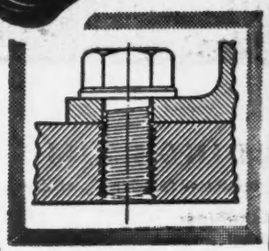

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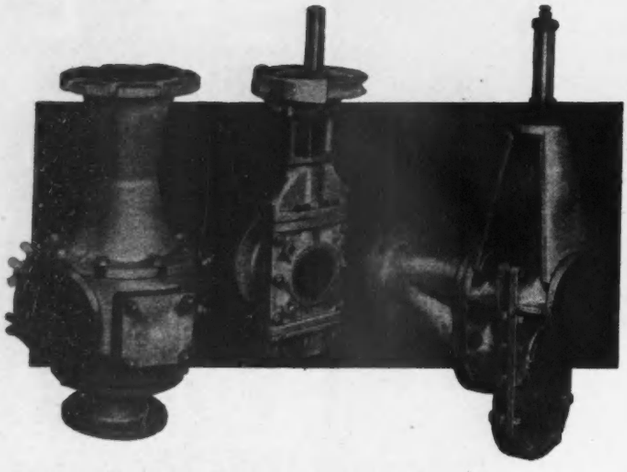

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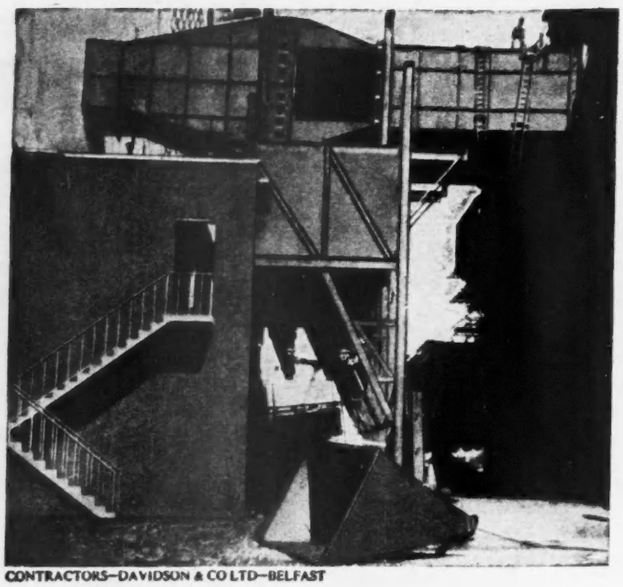

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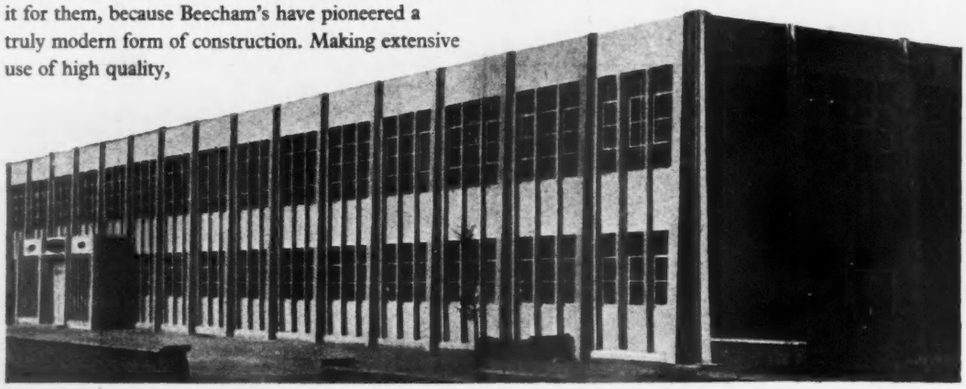

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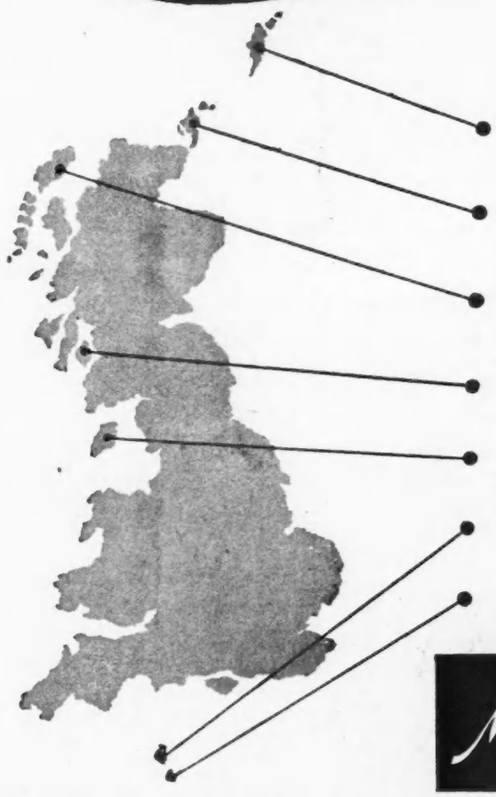

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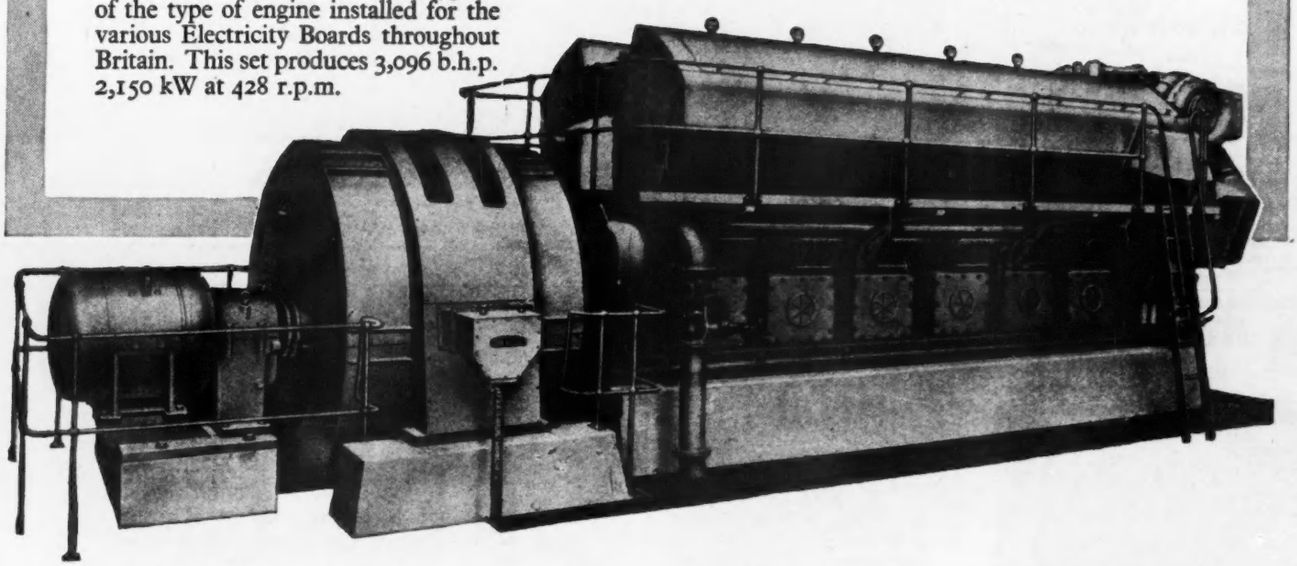

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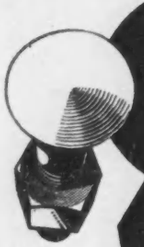

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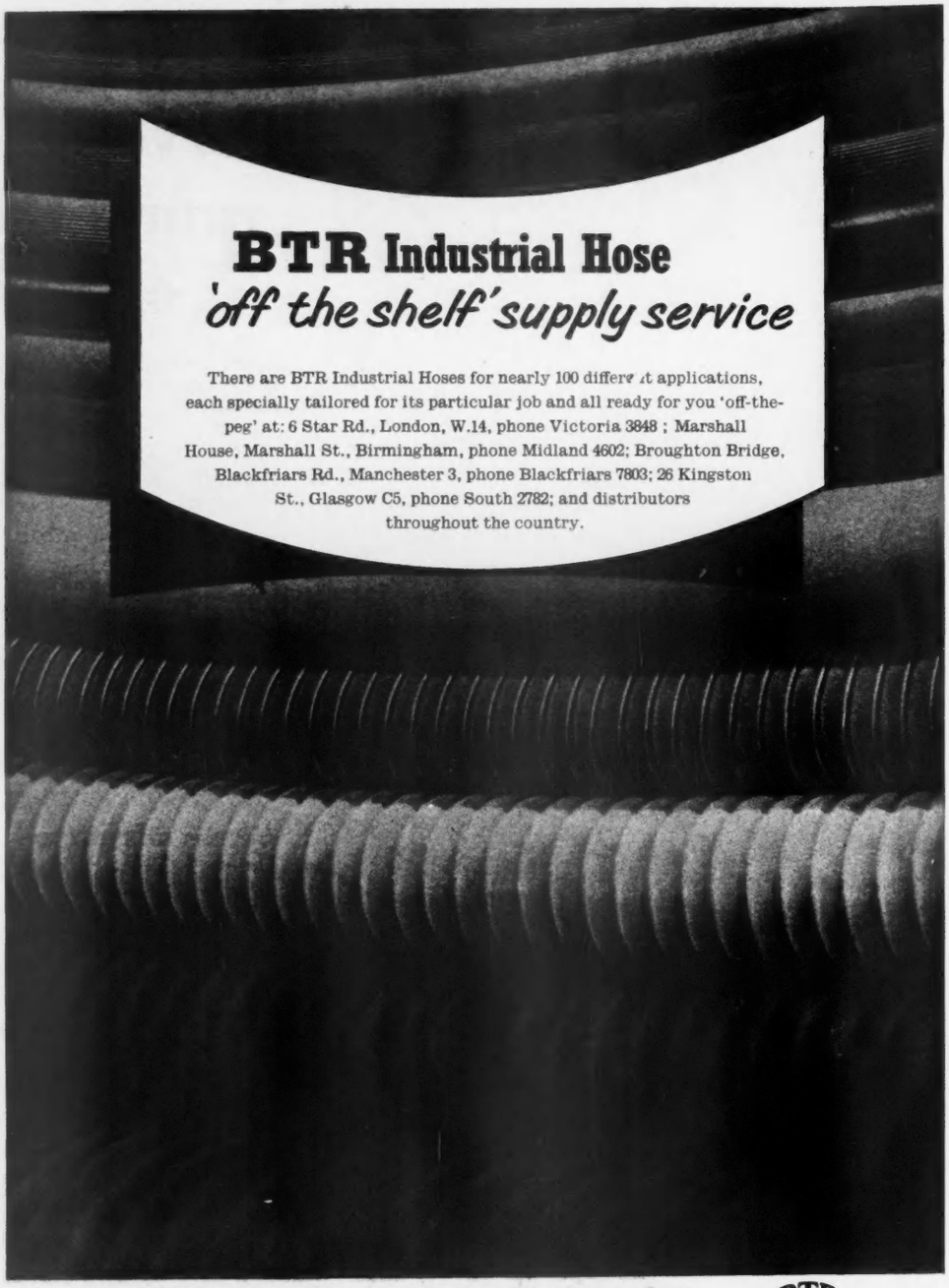

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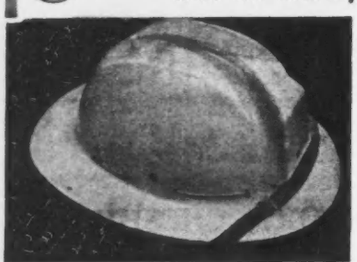

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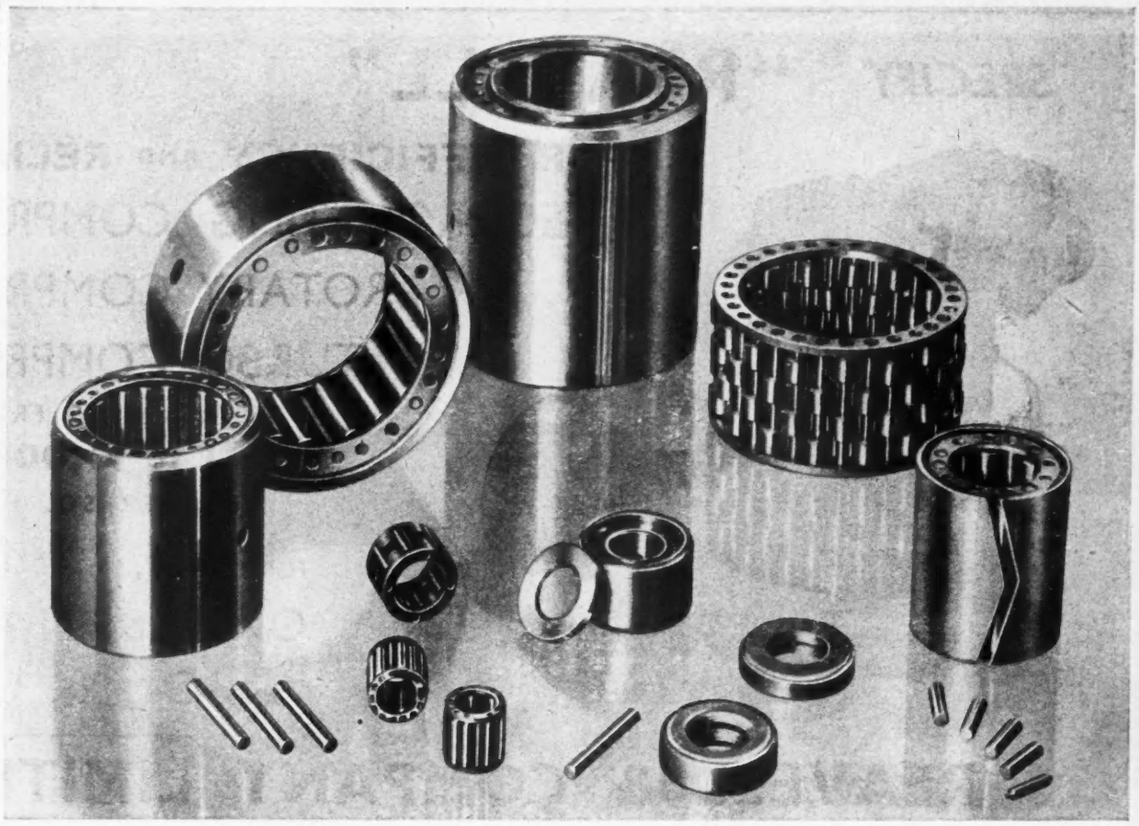

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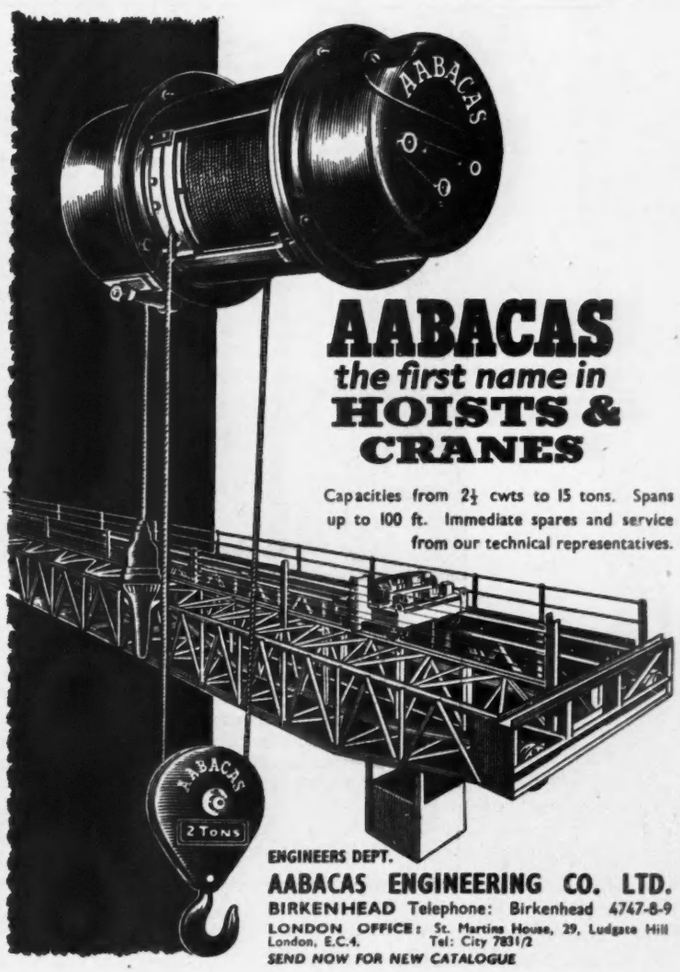

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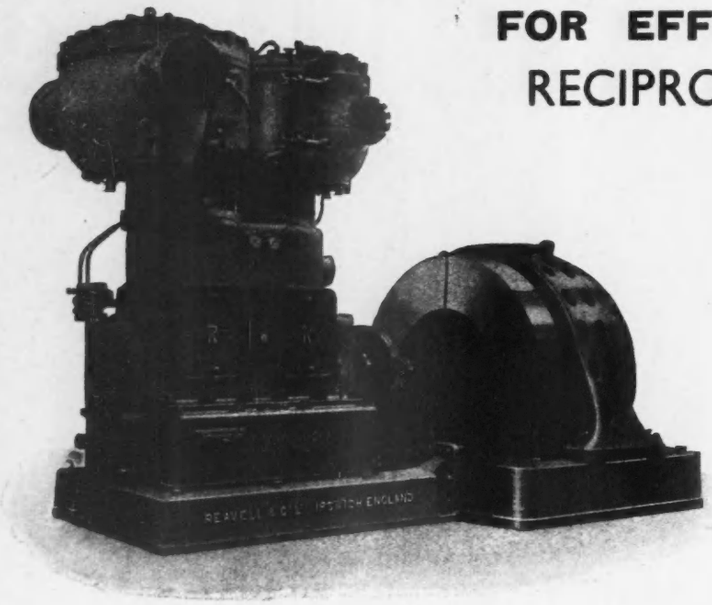

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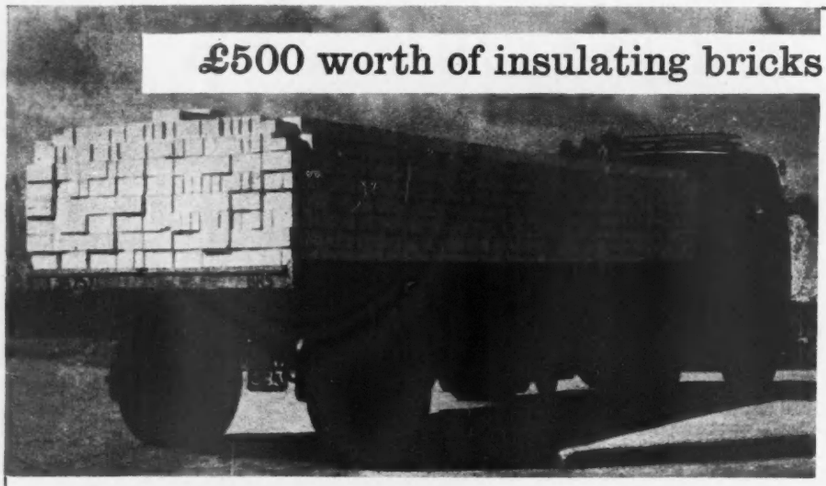

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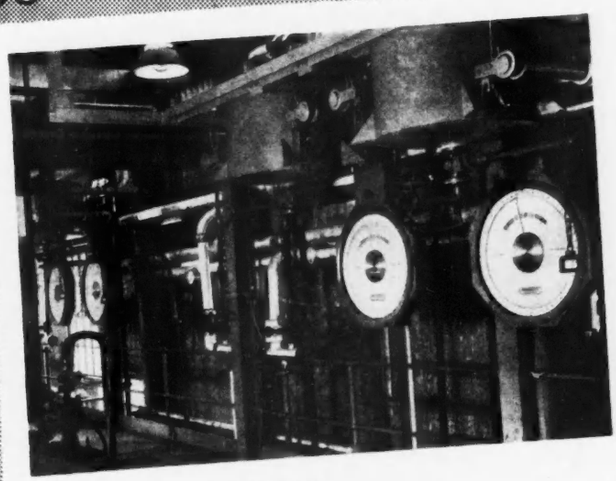

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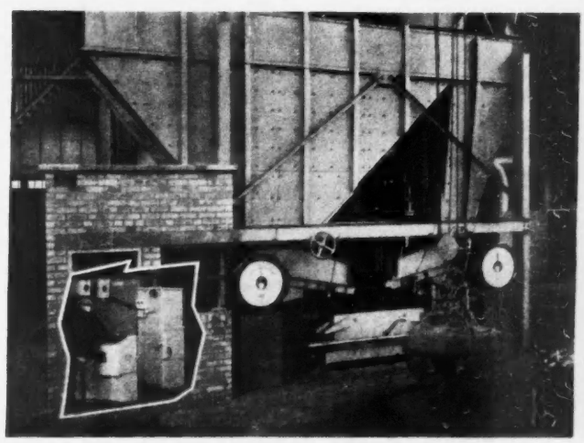

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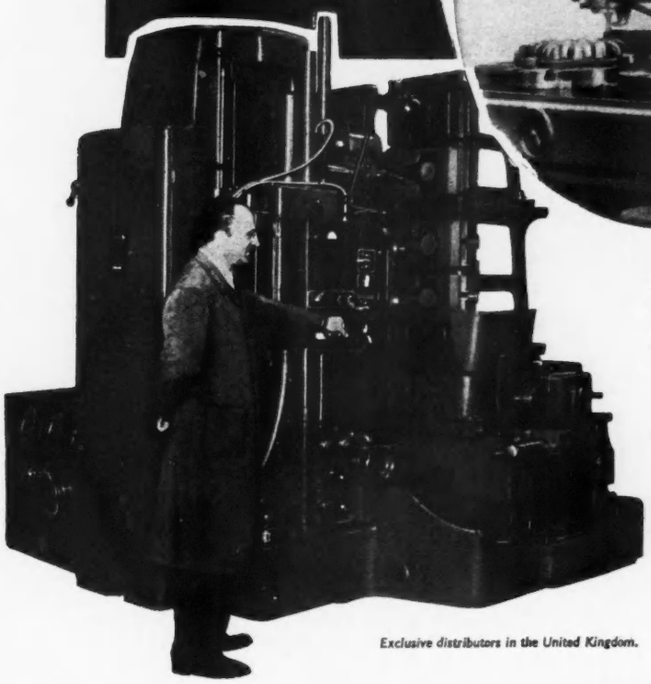

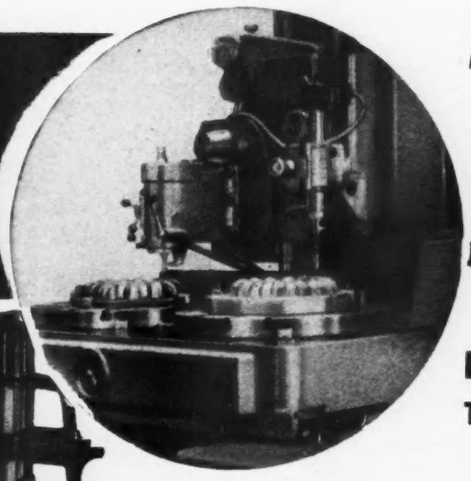

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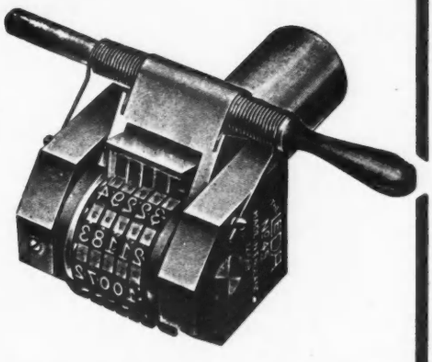

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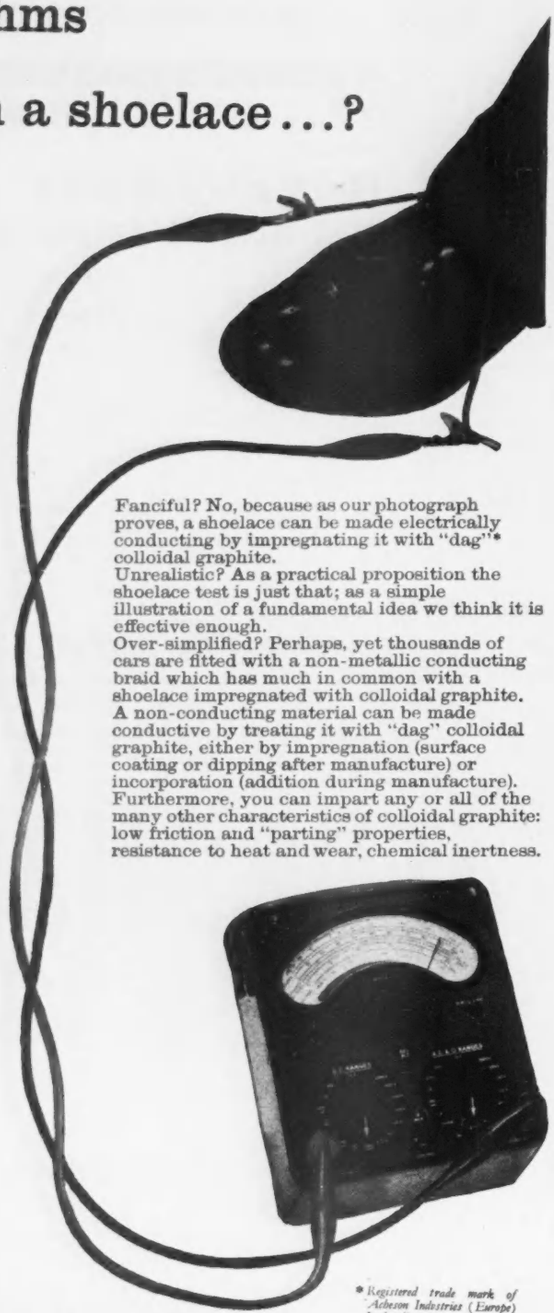

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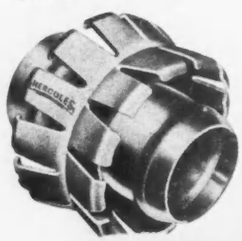

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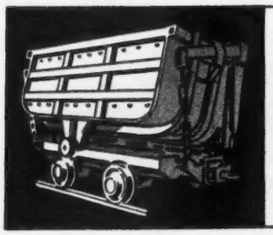

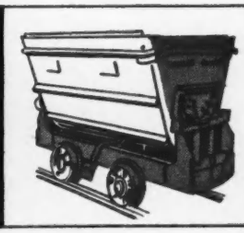

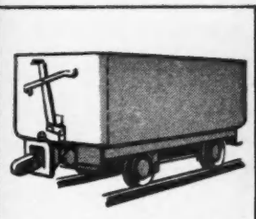

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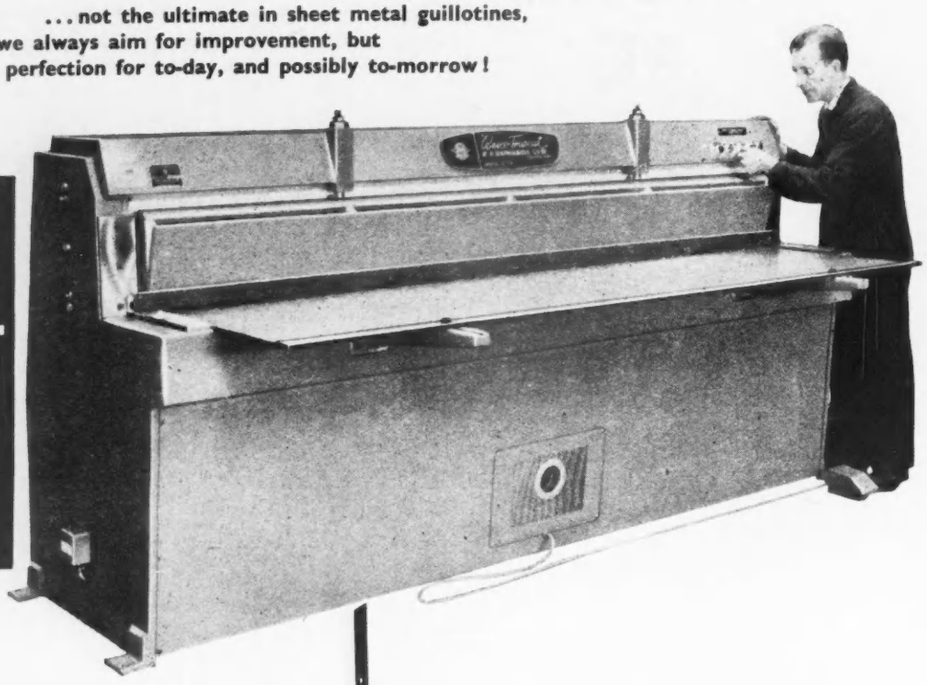

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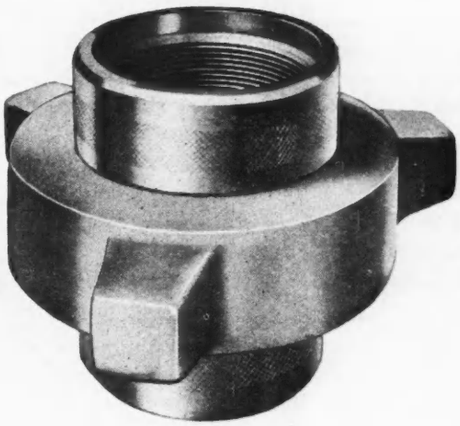
Phones: EUSton 4681 (7 lines) 3771 (4 lines)
Grams: Bescotools Norwest London

LANSDOWNE HOUSE,
41 Water Street, Birmingham, 3
Phones: Central 7606 8
Grams: Bescotools Birmingham 3

WOODFIELD PIPE UNIONS



...give trouble-free service

★ *Field proved.*

★ *Pressures up to 10,000 p.s.i.; working pressure.*

★ *API Standard threads.*

★ *Available anywhere.*

★ *Forged Steel or Malleable Iron— Rigid, Misaligning and Ball Swivels.*

IDECO WOODFIELD

WOODFIELD ROCHESTER LIMITED

FRINDSBURY WORKS · ROCHESTER · KENT

Phone: STROOD 78421 *Grams:* Woodfield Telex, Rochester *London Office:* 147 Victoria St., S.W.1

WOODFIELD MANUFACTURE IDECO OILFIELD EQUIPMENT

TILLEY

REGD.

lighting — heating

The Tilley Lamp Company manufacture a unique range of portable paraffin pressure Floodlights, Storm Lanterns, Lamps and Heaters for use in engineering and industry.

Illustrated can be seen the powerful, portable 5,000 c.p. Tilley Floodlight, the F.L.6, which gives 48 hours of independent light on only 6 pints of paraffin.

Also illustrated is the A.L.16, one of the many Lamps manufactured by The Tilley Lamp Company in co-operation with Railways throughout the world.

If you have a lighting problem involving independent, portable light we shall be pleased to co-operate with you in solving your difficulties.

*** HAVE YOU HEARD?**

We now have an equally efficient range of Lamps and Heaters operating on PROPANE/BUTANE.

Details of these will interest you.

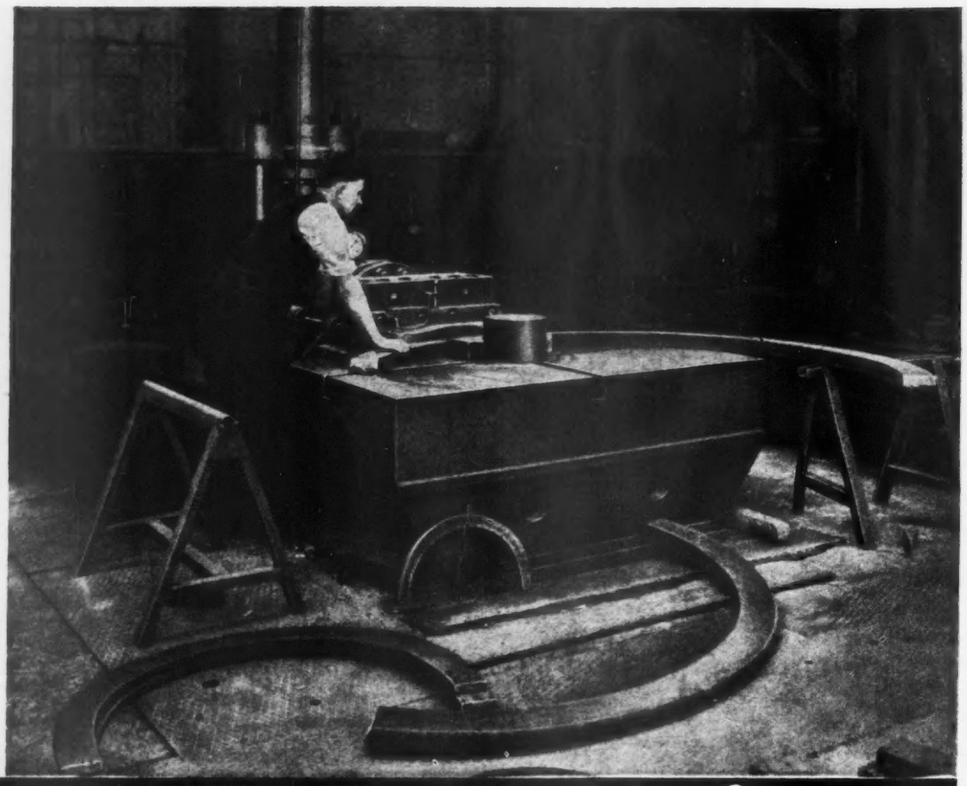
We recommend **ESSO BLUE**

Write to DEPT: EN1 :—

The TILLEY LAMP COMPANY LIMITED,
70-72 Jermyn Street, London, S.W.1

COLD WORKING

Forming half rings of 2" × 7" material to a diameter of 5' 0" on medium power press. Typical of robust Henry Berry design.



METAL FORMING *Machines*

Photos by Courtesy of The British Thomson-Houston Co., Ltd.

For bending heavy plates progressively.

Control of diameters during forming process effected by fine adjustment of built-in dies.

Capable of bending plates close to the edge.

We also manufacture: *High Pressure Hydraulic Plant for Shipyards and Railway Workshops, Plate Bending Rolls, Punching and Shearing Machines, Continuous Finishing Presses for Silks and Rayons, Veneer and Plywood Presses, Cotton Baling Presses, Die Spotting Presses, Pumps, Accumulators, Valves and Intensifiers.*

HENRY BERRY

& CO., LTD.

CROYDON WORKS, LEEDS, 10.

'PHONE: LEEDS 75481-2

GRAMS: "RIVETTER, LEEDS 10"

HB

CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and pro rata. 12 lines to 1 inch. There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

Inch Rate. 42/- per single column inch and pro rata. 12 lines to 1 inch. There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565

PUBLIC APPOINTMENTS

ROYAL TECHNICAL COLLEGE, SALFORD

DEPARTMENT OF MECHANICAL ENGINEERING

LECTURERS

Applications are invited for posts of ASSISTANT LECTURER, LECTURER, and SENIOR LECTURER in the Department of Mechanical Engineering.

This rapidly expanding Department of the College of Advanced Technology is developing exceptionally good conditions for teaching, consulting and research work. Applicants should have an Honours Degree in Engineering, or an equivalent qualification. Importance is attached to professional engineering or research experience. Teaching experience, though an advantage, is not essential. Staff are encouraged to develop their own interests and will be given assistance to carry out research and develop contact with industry or other organisations.

Salaries will be in accordance with the Burnham Technical Scales for Teachers in Establishments of Further Education. These are at present under review, but the revised scales will probably be :—

Senior Lecturer (men) : £1550 by £50 to £1750 per annum.

Lecturer (men) : £1370 by £35 (4) and £40 (1) to £1550 per annum.

Assistant, Grade "B" (men) : £700 by £27 10s. (15) and £37 10s. (1) to £1150 per annum, plus additions and allowances for graduate qualifications and approved study and training where appropriate.

Successful applicants may be placed at intermediate points in these scales in accordance with previous experience in an equivalent capacity and/or industrial experience.

Further particulars and forms of application may be obtained from the Registrar, Royal Technical College, Salford, 5, Lancs., to whom completed applications should be returned by 14th October, 1959.

R. RIBBLESDALE THORNTON,
E7442 Clerk to the Governors.

COUNTY BOROUGH OF ROTHERHAM EDUCATION COMMITTEE

ROTHERHAM COLLEGE OF TECHNOLOGY

SENIOR LECTURER

Applications are invited for the undermentioned post, duties to commence on 1st January, 1960.

DEPARTMENT OF MECHANICAL, PRODUCTION AND CIVIL ENGINEERING

SENIOR LECTURER to teach Mechanical Engineering subjects to Higher National Diploma (Sandwich) standard. Candidates should possess a degree or equivalent qualification and have had appropriate industrial and teaching experience.

Salary will be in accordance with the Burnham Further Education Report, 1959 : £1550 by £50 to £1750.

The starting position on the scale will be determined by previous teaching and/or industrial experience.

Application forms and further particulars may be obtained from the undersigned to whom completed forms should be returned within 14 days of the appearance of this advertisement.

R. BLOOMER,
Director of Education.
Education Offices,
Rotherham. E7433

WINDSOR GROUP HOSPITAL MANAGEMENT COMMITTEE

WORKS ASSISTANT

Duties include simple drawing and calculations associated with heating, domestic and steam installations, and keeping records of fuel, light and power, plant inspection, &c. Experience of heating and domestic supplies essential, and knowledge of steam and electricity an advantage. Salary, age 21, £415, 26 or over, £525 by £25 (4) to £625. —Reply, with names of two referees, to Superintendent Engineer, Windsor Group H.M.C., Alma Road, Windsor. E7402

PUBLIC APPOINTMENTS

ROBERT GORDON'S TECHNICAL COLLEGE, ABERDEEN

SCHOOL OF ENGINEERING

Head : H. HAMPSON, M.Sc.(Tech.). M.I.Mech.E.

LECTURER WITH QUALIFICATIONS IN CIVIL ENGINEERING

Applications are invited for the post of Grade I LECTURER.

Candidates should preferably possess an honours degree in Engineering or similar qualification, and must have had some practical experience in Civil Engineering design or contract work.

Salary Scale, £850 by £50 to £1350 per annum by £50 to £1475 per annum, plus 5 per cent, with placing on the scale according to qualifications and experience.

Duties to commence as soon as possible.

Further particulars and Forms of Application may be obtained from the undersigned, to whom completed applications should be returned by 6th October, 1959.

A. C. WEST,
E7434 Director.

NATIONAL COAL BOARD

DURHAM DIVISION

AREA CENTRAL WORKSHOPS MANAGER

Applications are invited for the above post in No. 2 (Mid-East Durham) Area of the Division. The Workshops are situated near Houghton-le-Spring. The appointment will carry a salary within the range £1250 to £1850. The starting salary will be in accordance with the qualifications and experience of the successful candidate. The number of men employed is about 600. The Works are engaged mainly on the overhaul and repair of electrical and mechanical coal mining plant and machinery. The post requires a person capable of supervising the overall working and administration of the Shops to achieve and sustain the maximum throughput of planned overhaul and jobbing work and of maintaining the required standards of workmanship and good personnel relationships. Candidates should have a general engineering background and preferably have some knowledge and experience of mining plant and equipment. They must be conversant with the repair of wagons to main-line standard. Experience in the heavy repair of steam and diesel locomotives is essential and candidates must have a knowledge of iron and brass foundry technique. The possession of a Higher National Certificate in Mechanical and/or Electrical Engineering or equivalent is essential.—Applicants should reply within 7 days quoting SG/290/8(78) and giving full details of age, education, qualifications and experience to N.C.B., 7 Side, Newcastle upon Tyne, 1. E7425

THURROCK URBAN DISTRICT COUNCIL

ENGINEER AND SURVEYOR'S DEPARTMENT

APPOINTMENTS

Thurrock Urban District Council (population 105,000—rapidly increasing) (Engineer and Surveyor's Department) require (a) ASSISTANT ENGINEER. Salary, A.P.T. IV, £1065–£1220 p.a. Applicants should be Chartered Civil or Municipal Engineers, or have equivalent qualifications, and have extensive civil engineering experience, and be capable of designing and supervising construction of major schemes. In particular, experience is desired in sewerage and sewage disposal. Housing accommodation may be considered if successful candidate resides more than 20 miles from Thurrock. (b) TWO ENGINEERING ASSISTANTS. Salary, A.P.T. I/II, £610–£880 p.a. Applicants should have completed their training in a Municipal or Civil Engineer's Office and have had some subsequent experience. Appointments pensionable.—Applications, stating age, qualifications and experience, and quoting three referees, to the Clerk of the Council, Council Offices, Grays, Essex, by 6th October, 1959. Canvassing disqualifies. Relationship with members or senior officers of the Council must be disclosed. E7395

PUBLIC APPOINTMENTS

BRITISH TRANSPORT DOCKS

CHIEF DOCKS ENGINEER'S DEPARTMENT, HUMBER PORTS, HULL

ENGINEERING ASSISTANT

British Transport Docks invite applications for the position of ENGINEERING ASSISTANT in the Chief Docks Engineer's Department, Humber Ports, Hull.

Applicants must be qualified in reinforced concrete design and have experience in preparing contract drawings and bills of quantities ; experience of dock and harbour structures an advantage. Corporate Membership of the Institution of Civil Engineers or of the Institution of Structural Engineers essential. Commencing salary £1095 per annum, contributory superannuation scheme and certain rail travel facilities.

Applications, giving age, experience and present position, should be forwarded to : Staff and Establishment Officer, British Transport Docks, 163, Euston Road, London, N.W.1, to arrive not later than Saturday, 3rd October, 1959. E7419

METROPOLITAN BOROUGH OF SAINT PANCRAS

ENGINEER AND SURVEYOR'S DEPARTMENT

RESIDENT ENGINEER

Applications are invited for the position of RESIDENT ENGINEER in connection with the rebuilding of Prince Albert Road Bridge.

The work consists of the replacement of an existing brick arch structure by a reinforced concrete bridge whilst maintaining continuity of extensive services and canal traffic and is due to commence at the beginning of next year.

The salary will be in the range of £1220–£1375 plus £30 per annum London Weighting.

Applications, stating age, qualifications and experience, together with the names and addresses of two referees, should be addressed to Messrs. L. G. Mouchel and Partners, Consulting Civil Engineers, 38 Victoria Street, S.W.1. E7409

CIVIL SERVICE COMMISSION

MECHANICAL AND ELECTRICAL ENGINEERS

Pensionable posts for men and women normally under 35 on 1st September, 1959. Applicants must normally have Degree in Engineering or Physics (or Dip. Tech. for some posts), or have passed examinations necessary for A.M.I.Mech.E., A.M.I.E.E., A.F.R.Ae.Soc., &c. Exceptionally, evidence of high professional attainment acceptable in lieu. Practical training and experience required but untrained Graduates acceptable for some posts. Men's starting salary (London) from £830 (lower if under 25) to £1125. Maximum £1300. Promotion prospects.

Write, Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S851/59/9. Closing date : 15th October, 1959. Earlier applicants may be interviewed before that date. E7412

GROUP 25, BIRMINGHAM HOSPITAL MANAGEMENT COMMITTEE

DEPUTY SUPERINTENDENT ENGINEER

The Group comprises thirteen hospitals and the post carries responsibility for acting as deputy to the Superintendent Engineer over the whole range of his duties, including planning and maintenance of steam, hot water plant and services, associated electrical services as well as maintenance of buildings. Candidates must possess Higher National Certificates or equivalent and must be able to draw up plans and specifications and have had experience in all branches mentioned above. Commencing salary £805 rising by five annual increments to £940 p.a. No accommodation available. Applications in writing, with names of two referees, to Secretary, Group 25, Birmingham (Selly Oak) Hospital Management Committee, Oak Tree Lane, Birmingham, 29. E7401

PUBLIC APPOINTMENTS

SOUTH WEST SUBURBAN WATER COMPANY

ASSISTANT ENGINEER

Applications are invited for the above vacancy in the Chief Engineer's Department.

Candidates should be about 26 years of age and have passed the Professional Interview of the Institution of Civil Engineers' examination or the equivalent thereof. They must have had at least 4 years' experience in the water, municipal or civil engineering industries.

Duties will be to assist in the day-to-day running of the undertaking and, in particular, with filtration problems. At present treatment of Thames water is by sedimentation followed by rapid gravity and slow sand filtration. The person appointed will help to develop a method of treatment permitting slow sand filtration to be discontinued. New works to be put in hand shortly include a 3 M.G. service reservoir, electrification of engine house, new river intake and numerous main extensions. The Company serves an area of 100 square miles with a population of 200,000.

The salary offered is upwards of £900 p.a., according to qualifications and experience.

The appointment, which is subject to medical examination, is permanent and pensionable. There are prospects of promotion.

Applications, stating age, qualifications and experience, should be sent to the Chief Engineer, The Causeway, Staines, Middlesex, by October 10th, 1959.

J. R. BROCK GRIGGS, B.Sc., A.M.I.C.E., M.I.W.E.,
E7385 Chief Engineer.

NATIONAL ENGINEERING LABORATORY (D.S.I.R.)

EAST KILBRIDE, GLASGOW

SENIOR SCIENTIFIC OFFICERS/ SCIENTIFIC OFFICERS

National Engineering Laboratory (D.S.I.R.), East Kilbride, Glasgow, requires SENIOR SCIENTIFIC OFFICERS/SCIENTIFIC OFFICERS in Metrology Division. Post 1. (Ref. F 156/9A). METALLURGIST or PHYSICIST for research on gears with special reference to pitting. Experience of physical metallurgy essential. Post 2. (Ref. C 620/9A) ENGINEER for research on mechanisms or large-scale metrology. Experience in industrial design essential. Research experience desirable.

Qualifications : 1st or 2nd Class Honours Degree or equivalent. For S.S.O. at least three years' post-graduate experience.

Salary (men) : S.S.O., £1166–£1380 ; S.O., £615–£1090. Allowance for N.S. and post-graduate experience. Houses available for married staff in New Town.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting appropriate reference number. Closing date : 23rd October, 1959. E7414

EXPLOSIVES RESEARCH AND DEVELOPMENT ESTABLISHMENT

MINISTRY OF SUPPLY, WALTHAM ABBEY, ESSEX

PHYSICIST, MECHANICAL OR CHEMICAL ENGINEER

PHYSICIST, MECHANICAL or CHEMICAL ENGINEER required at Explosives Research and Development Establishment, Ministry of Supply, Waltham Abbey, Essex, to lead small team on experimental studies of Heat Transfer Phenomena at very high temperatures and high velocities, and on physical properties of materials at extreme temperatures. Excellent opportunity for individual research in this relatively new field. Appointment in grade of Senior Scientific Officer. Salary : £1233–£1460. Minimum age 27. Superannuation under F.S.S.U. First or Second Class Honours Degree and at least three years' post-graduate research experience required. Housing may be available within reasonable time for married men.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1. (quoting A.406/9A). E7413

Classified Advts. continued on page 160

PUBLIC APPOINTMENTS

HASTINGS GROUP HOSPITAL MANAGEMENT COMMITTEE

ASSISTANT ENGINEER

Applications are invited for the post of ASSISTANT ENGINEER at the Darvell Hall Hospital, Robertsbridge, Sussex. Salary scale : £575 by £25 (5) to £700 per annum.

Applicants must have served a recognised engineering apprenticeship and have sound knowledge and experience of Steam Boiler plants, laundries, heating and domestic hot water services and electrical installations. The successful candidate will be responsible to the Superintendent Engineer for general Maintenance at the hospital and will be required to reside on the premises, where a house is available at a reasonable rental.

Applications, stating age, qualifications and experience, with the names of two referees who can testify to technical ability, should be forwarded to the Group Secretary, 11, Holmesdale Gardens, Hastings, Sussex. E7450

TENDERS

UPPER WITHAM INTERNAL DRAINAGE BOARD

OX-PASTURE PUMPING SCHEME

The Board invites TENDERS for the following works, situated about seven miles west of Lincoln :

1. A PUMPING STATION in steel piling, reinforced concrete and brickwork, to house three 27in. diameter electrically-driven pumps, to be supplied by Messrs. Gwynnes Pumps, Ltd.
2. The reconstruction of a small ROAD BRIDGE.
3. The DEEPENING and EMBANKING of part of the OX-PASTURE DRAIN.

General Conditions, Specification, Bills of Quantities and form of Tender may be obtained from the Consulting Engineers, Messrs. Grantham, Brundell and Farran, 20, South Parade, Doncaster, Yorkshire, upon payment of a deposit cheque for five guineas made payable to the Board and crossed, which will be returned on receipt of a bona-fide tender and the return of all documents.

Drawings may be inspected at the offices of the Consulting Engineers or at the offices of the Board.

Tenders on the official form are to be delivered to the undersigned in plain sealed envelopes endorsed " Tender for Ox-Pasture Pumping Station " not later than noon on Monday, October 26, 1959.

The Board do not bind themselves to accept the lowest or any tender.

W. EPTON,
Clerk to the Board.

20, Orchard Street,
Lincoln. E7408

GOVERNMENT OF HONG KONG

SHEK PIK WATER SCHEME

LAYING TWIN SUBMARINE PIPELINES

The Government of Hong Kong invites TENDERS from Contractors with experience of laying submarine pipelines for the LAYING of TWO 30 inch diameter STEEL PIPELINES to carry filtered water from Lan Tao Island to Hong Kong.

The main items of the works are :—

(a) Welding, Bitumen Sheating and Concrete Cladding of the pipes which are supplied by the Government of Hong Kong.
(b) Laying the pipes as twin pipelines each about 8 miles long, and burying them below the sea bed.

The contract documents can be inspected at the office of the undersigned and can be obtained from them on payment of twenty-five pounds during the period 2nd November, 1959, to 1st February, 1960—the deposit to be refunded on receipt of a bona fide Tender.

Sealed Tenders, endorsed " Tender for Shek Pik Submarine Pipeline " and addressed to the Chairman of the Tender Board, Colonial Secretariat, Lower Albert Road, Hong Kong, must be delivered to the above address by noon on 1st June, 1960.

Tenderers are warned that the fair weather season which is suitable for site investigation is limited to the period beginning in November and ending in May.

The Government of Hong Kong does not undertake to accept the lowest or any Tender, nor will expenses in connection with Tendering be defrayed, but Tenderers must make themselves fully acquainted with the site and conditions of work.

BINNIE, DEACON AND GOURLEY,
Artillery House,
Artillery Row,
Westminster,
London, S.W.1. E7381

INDIA SUPPLY MISSION

The Office of India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington, 8 D.C., United States of America, invites tenders for the following :

TENDER ENQUIRY No. SE 104

For the SUPPLY OF TYRE RETREADING EQUIPMENT such as tyre moulds of various sizes, detreader, vulcanising equipment, buffing machines, power stitcher and spreaders.

Specifications, &c., relative to the above specification, can be obtained from the Co-ordination Branch, India Store Department, Bromyard Avenue, Acton, W.3, at a cost of £1 1s. 5d. per tender and is not refundable. Tenders are to be returned direct to India Supply Mission, 2536, Massachusetts Avenue, N.W. Washington, 8 D.C., United States of America, so as to reach them by 3rd November, 1959.

Specimen copy of the above enquiries can be seen at India Store Department, Engineering Branch, Bromyard Avenue, Acton, W.3, under the following reference : S.3525/59/NSC/ENG.2. E7417

TENDERS

DUNMOW RURAL DISTRICT COUNCIL

WILLOWS GREEN AND CAUSEWAY END, FELSTED

SEWERAGE AND SEWAGE DISPOSAL

CONTRACT NO. 14

Tenders are invited on a fixed price basis in accordance with the Ministry of Housing and Local Government Circular No. 31/57 for the construction of SEWERAGE AND SEWAGE DISPOSAL WORKS at Willows Green and Causeway End.

The Sewage Disposal Works to be constructed at Willows Green will comprise a pyramidal sedimentation tank, biological filter pyramidal humus tank, concrete sludge digestion tank, sludge drying area, stormwater irrigation area, pumping station in reinforced concrete, ancillary pipework, access road and paths.

The Sewerage in Willows Green and Causeway End comprises in all the laying of about 2400 linear yards of 9in. diameter S.G.W. sewer, 2300 linear yards of 6in diameter S.G.W. sewer, together with 4in. and 6in diameter S.G.W. house connections and the construction of 13 brick and 38 precast concrete manholes.

General Conditions of Contract, Specification, Bills of Quantities and Drawings may be obtained from the Council's Consulting Engineers, Messrs. J. D. and D. M. Watson, MM.I.C.E., 67, Tufton Street, Westminster, S.W.1, on and after 5th October, 1959, on payment of a deposit of ten guineas, refundable only to Contractors who submit bona fide tenders and return all documents and drawings. Deposit cheques should be made payable to Dunmow Rural District Council.

The Council do not bind themselves to accept the lowest or any tender.

Tenders must be returned in envelopes which do not bear any name or mark indicating the sender, endorsed " Tender for Sewerage Contract 14 " and delivered at the office of the undersigned by noon on 13th November, 1959.

A. H. BURTON,
Clerk of the Council.

Council Offices,
Dunmow, Essex. E7423

EDUCATIONAL

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

BRITISH INDUSTRIAL SAND, LTD. High Street, Godstone, Surrey. DRAUGHTSMEN required by rapidly expanding Quarrying Organisation, O.N.C. or H.N.C. Mechanical Engineering an advantage, for work on mechanical handling, conveying plant, structures, &c. Site visiting would be included in duties. Excellent prospects for the right men. There is a Staff Pension Scheme in operation. E161 A

CHIEF ENGINEER required for Aluminium Rolling Mill in South Wales. This is a progressive factory in an expanding industry and is part of a large Industrial Group. Applicants should preferably have previous Rolling Mill experience. This is an important senior Management position which offers excellent experience and prospects. Assistance with housing can be given if required.—Applications, giving full details of career and current salary, should be addressed to the Plant Manager, Reynolds T.I. Aluminium, Ltd., Rheola Works, Resolven, Glamorganshire, South Wales. E7426 A

CHEMICAL ENGINEER

Large modern Producers of Man-Made Fibres, with international connections and first-class research facilities, require a CHEMICAL ENGINEER with ability to apply first principles to plant investigation and design. Age preferably 24–45. Good salary and prospects for suitable applicant. Pension scheme. Assistance with housing.—Applications, which will be treated in strict confidence, should give age, qualifications, experience in sequence, and be addressed to Personnel Manager, British Enka, Ltd., Aintree, Liverpool.

E7391 A

COMPETENT ENGINEER required to take charge of all services in a food factory in South Wales. The First M.O.T. Certificate (Steam) is desirable. The post is permanent with superannuation scheme and a good salary in accordance with qualifications.—Applications will be treated in strict confidence and should be addressed to BOX No. E7383, " The Engineer." A

DESIGN DRAUGHTSMAN ESTIMATOR, required by London Office of a West Midland Constructional Engineers with experience of concrete batching systems and similar equipment, must be able to work on own initiative and be used to dealing direct with clients.—Write, in first instance, giving particulars of experience, salary required, &c., to BOX No. E2550, " The Engineer." A

DESIGN ENGINEER required in an expanding Technical department dealing with marine reduction gears and V.P. propellers. Good salary for experienced man with right technical background. Pension scheme. Applications to the Technical Manager, giving full details of education, qualifications, age, experience and present salary.—MODERN WHEEL DRIVE, LTD., Lindo Lodge, Chesham, Bucks. E7276 A

SITUATIONS VACANT

DEVELOPMENT ENGINEER required by London Engineering Company for the development of Rear Axles, Differentials and Transmissions for the Automotive Industry. Theoretical and practical experience essential. Duties will include the supervision of tests and of a proposed dynamometer installation. Excellent prospects, superannuation scheme.—Write in full confidence, stating age, experience, qualifications, positions held, &c., to BOX C.749, c/o Streets, 110, Old Broad Street, E.C.2. E7362 A

DRAUGHTSMAN-DESIGNER in Structural Steelwork required by Unilever, Ltd., at their London Office, dealing with wide range of interesting work on industrial and commercial buildings of many types. Good knowledge of standard practice and code requirements essential ; knowledge of reinforced concrete, foundations and general building work a distinct advantage. Five-day week ; superannuation scheme ; permanent position to right man.—Applications, giving details of age and experience, should be addressed to Head Office Staff Department (WF 44), Unilever House, Blackfriars, London, E.C.4. E7416 A

EXECUTIVE MECHANICAL ENGINEER

Applications are invited from Engineers with creative and administrative ability coupled with experience in the design of Heat Transfer Plant. The successful candidate will be required to take charge of the Heat Transfer Division of an established medium-sized Company. Remuneration will be commensurate with the status of the post and calibre of the candidate.—Applicants should state age, present salary level and give details of training, qualifications and experience. —BOX No. E2549, " The Engineer."

A

FLUIDRIVE ENGINEERING CO., LTD., Fluidrive Works, Worton Road, Isleworth, Middlesex, require DESIGN AND DETAIL DRAUGHTSMEN experienced in power transmission work. H.N.C. standard preferred. Good salary and conditions.—Write Chief Designer.

E7446 A

FORENSIC ENGINEERS invite applications from Engineering Graduates with good background and industrial experience for responsible and individualistic post. Age not over 32.—BOX No. E7299, " The Engineer." A

GENERAL MECHANICAL ENGINEERING FIRM in West of Scotland requires practical ENGINEER to act as Plant Superintendent and also to give assistance to Managing Director. Should have knowledge of Planes, Horizontal Borers, Vertical Borers, Lathes, Shapers, &c., and Cranes up to 20-ton lift. Production includes Steel Works Plant and General Machine Work. Applicants should have H.N.C. qualification or higher, and some electrical knowledge would be advantageous. Salary £1000–£1300 according to qualifications. Non-contributory Superannuation Scheme.—Applications with all particulars to BOX No. E2547, " The Engineer." A

GENERATION ENGINEER

A major British oil company urgently requires a GENERATION ENGINEER to take charge of a gas turbine power station now under construction in India.

Applicants must hold a Higher National Certificate or equivalent in Mechanical Engineering and have at least three years' responsible experience in the operations and maintenance of steam turbines in a modern power station. Experience of gas turbines would be an advantage, but this is not essential.

Age limit : 35 years.

Applicants having some electrical engineering experience would be preferred.

Pay is good, and in addition the company provides free passages, free furnished accommodation, initial kit allowance, six months' leave on full salary and contracts of three years renewable. Free medical attention is available to employees and their dependants.

The successful applicant would be given a short period of gas turbine training and experience at manufacturers' works in this country before proceeding abroad.

Write to Box TE.193, c/o 191, Gresham House, E.C.2, as soon as possible please.

E7373 A

JOHN LAING AND SON, LIMITED

have the following vacancies in their Research and Development Centre, at Boreham Wood, Herts.

MECHANICAL DESIGN DRAUGHTSMEN of H.N.C. standard with good experience in the design of building and civil engineering plant.

These posts are progressive and pensionable. The work is varied and interesting and holds attractive prospects in an expanding field. Canteen and Sports Club facilities. Five-day week.

Apply in writing, stating age, experience, &c., to Personnel Manager (MDD13), John Laing and Son, Ltd., London, N.W.7. E7316 A

MECHANICAL AND CIVIL ENGINEERING DRAUGHTSMEN required for a Drawing Office engaged on all types of work connected with Mining, Quarrying, Hydraulics and Industrial Building Construction. A Superannuation Scheme is in operation.—Applications stating qualifications, experience and salary required should be made to the Chief Engineer, Messrs. Clays Lovering Pochin and Co., Ltd., 14, High Cross Street, St. Austell, Cornwall. E7448 A

SITUATIONS VACANT

MANCHESTER CORPORATION TRANSPORT DEPARTMENT

REQUIRE A FULLY QUALIFIED

TECHNICAL ASSISTANT

Applicants must have passed the final examination of the Institution of Mechanical Engineers or its equivalent.

Salary in accordance with the special basic grade of the National Scales, i.e. £785–£1070 per annum. Point of entry according to experience.

Forms of Application may be obtained from the General Manager, 55, Piccadilly, Manchester, 1, and should be returned not later than 7th October, 1959.

E7447 A

MECHANICAL ENGINEER, with some electrical knowledge, required to join a group engaged on design and site supervision of oil products pipeline and distribution depots in Iran. Knowledge of petroleum practice is essential. Applicants should be aged about 35 years and have design experience of pumping and ancillary equipment. Applicants will be required to work in London in the first instance.—Send fullest particulars to Staff Office, Rendel, Palmer and Tritton, Consulting Engineers, 125, Victoria Street, S.W.1. E7392 A

MECHANICAL ENGINEERING DRAUGHTSMEN

A number of experienced Draughtsmen are required for work on mechanical engineering projects, which include structural steelwork ; much of the work will be concerned with the design of plant and equipment for mines.

Applicants should have served a recognised engineering apprenticeship and have obtained the H.N.C. in Mechanical Engineering ; they should also have had experience with a medium or heavy engineering company in the preparing of designs for one-off or small batch production. Age should preferably be 23–35.

Basic salary will be in the range £600–£750 (according to ability and experience), plus a Company productivity bonus of 20½ per cent. Five-day week ; overtime paid. Contributory pension scheme.

When making initial application, brief details of qualifications should be given : full details will be required later when completing the application form. Address as below.

QUALTER, HALL AND CO., LTD.,
P.O. Box 8, Railway Foundry, Barnsley.
E2545 A

RICHARD THOMAS AND BALDWINS, LIMITED

have vacancies for

MECHANICAL ENGINEERS AND DRAUGHTSMEN

at their

CENTRAL ENGINEERING DEPARTMENT

to be located at

SPENCER WORKS, LLANWERN, NEAR NEWPORT, MON.

The department is organised on a functional basis, and responsibility is given within the following divisions :

Iron and Steel
Hot and Cold Rolling
Processes and Finishing

Applications are invited for the following positions to assist in the design, development and layout of plant associated with the manufacture of Iron, Steel, Sheet, Tinplate and Finished Products at the works of the Richard Thomas and Baldwins, Ltd., Group of Companies.

PROJECTS ENGINEERS
ENGINEERS
ASSISTANT ENGINEERS
SENIOR DRAUGHTSMEN
JUNIOR DRAUGHTSMEN

The range of specialisation is not rigid, but applicants should be trained and experienced in design and development work associated with modern Steel plant, Rolling Mills and Finishing Equipment or comparable installations in medium or heavy industrial engineering.

Salary scales commensurate with qualifications and experience. Contributory Staff Pension and Life Assurance Schemes.

Application form can be obtained by writing to :

General Manager—Engineering,
Richard Thomas and Baldwins, Limited,
Central Engineering Department,
" Coed Parc,"
42, Park Street, BRIDGEND, Glam.

Envelopes to be endorsed " MECHANICAL."

E7400 A

PLANNING ENGINEER required. Must have machine and Assembly Shop experience, sound knowledge of modern Jig and Tool design, operation layout and general tooling, conversant with rate fixing and cost investigation and analysis. Ability to follow up from development stage through to production—sound engineering workshop experience. Must have served apprenticeship.—Write, stating age, education, previous positions held, and salary required, and when available, to : General Works Manager, Saml. Denison and Son, Ltd., Hanslet Foundry, Leeds 10. E7405 A

SITUATIONS VACANT

METALLURGIST

required by the National Coal Board at their Central Engineering Establishment, Stanhope Bretby, Nr. Burton-on-Trent, to assist generally in metallurgical investigations (e.g. of service failures) and preferably to have had experience in carrying out metallurgical analysis of various materials. Applicants should have H.N.C. in Metallurgy or Chemistry or equivalent qualifications. Appointment superannuable, and salary according to qualifications and experience, within £930–£1080 or £640–£860.—Write for application form to the Administrative Officer (X.1507/2 C), at the above address, which should be returned by 6th October, 1959.

E7418 A

PLANT ENGINEER interested in Milling required to supervise installation of, and run new plant, on Merseyside. Apply, stating age, qualifications and experience. Pension Scheme. Housing Assistance if required.—Box No. B809, Lee and Nightingale, Ltd., Liverpool. E7436 A

SITUATIONS VACANT

SALES ENGINEER with wide experience in hydraulic transmissions and circuits required to manage a sales company specialising in hydraulic equipment.—BOX No. E2555 "The Engineer." A

SALES ENGINEER

required by progressive and expanding engineering company in South West London, manufacturing capital plant and machinery sold throughout the world for a basic industry. Previous sales experience unnecessary, but good general education and sound engineering training essential with H.N.C. or preferably a Degree. Student apprenticeship with a large firm an advantage. Permanent position with excellent opportunities for advancement. Contributory pension scheme. Starting salary dependent on age and qualifications, but we want a good young engineer, age 25–32, with a bent for technical sales who will be worth much more to us when he has learned his work.—BOX No. E7375, "The Engineer." A

BOOKS and PUBLICATIONS

New Books

APPLIED HYDRODYNAMICS

By Professor H. R. VALLENTINE, *Department of Civil Engineering, University of New South Wales.* 1959. *Price* 50*s.*

This book is intended for use in universities as an introduction to Hydrodynamics for students of Applied Mathematics, and as a course in Fluid Dynamics for senior and post-graduate students in Civil, Mechanical and Aeronautical Engineering. It has a bias towards practical application, differing from those established hydrodynamic works which are essentially mathematical treatises.

HYPERSTATIC STRUCTURES

Volume 1 : *An Introduction to the Theory of Statically Indeterminate Structures.*

By Professor J. A. L. MATHESON, *Department of Engineering, University of Manchester.* 1959. *Price* 90*s.*

The early work on the theory of indeterminate structures established many of the important principles, especially those involving the concept of strain energy, and enabled the structures of that time to be satisfactorily analysed. But the introduction of rigidly jointed frames brought formidable computational difficulties which were only overcome when the concept of successive approximations appeared. In recent years a great many variations of this concept have been published, and the student now finds himself faced with a bewildering variety of apparently unrelated theorems and methods of analysis.

The book treats the subject of hyperstatic structures as an organic and coherent whole. The relationship between the various energy theorems is demonstrated by a consideration of non-linear structures ; the theorems and methods applying only to linear structures are then treated in their logical order, special attention being paid to the broad distinction between the 'equilibrium' and 'compatibility' approaches.

The work is published in two complementary volumes : the second volume, to be published Spring, 1960, contains worked examples and problems for solution.

DESIGN of LAND DRAINAGE WORKS

By R. B. THORN, B.Sc., and Associates. 1958. *Price* 35*s.*

A handbook on detailed design for everyday use by both the experienced designer and the newly graduated engineer faced with his first design problems. The works dealt with are those carried out by River, Conservancy, Catchment and Drainage Boards and by similar authorities such as Irrigation and Drainage Departments.

The papers, selected from the Proceedings of the Institution of Civil Engineers, the Institution of Water Engineers and from technical journals, have been revised and brought up to date by authors who are all experienced engineers of the highest standing.

Butterworths Scientific Publications

4 & 5 Bell Yard, London, W.C.2

Electronic Engineering

A monthly journal for the professional electronics engineer. It circulates to 86 different industries all over the world.

When electronic engineering is studied "Electronic Engineering" is read.

28 ESSEX STREET, STRAND, LONDON, W.C.2

Telephone: Central 6565

Published by Morgan Bros. (Publishers) Ltd.

SITUATIONS VACANT

MUNICIPAL MUTUAL INSURANCE LTD. has Vacancies for MECHANICAL ENGINEER SURVEYORS in London and Birmingham. Posts are pensionable and permanent to satisfactory candidates who should have served an apprenticeship and have sound practical and theoretical knowledge. Technical qualifications : Ministry of Transport Certificate. Also, CRANE AND LIFTING TACKLE SURVEYOR with Higher National Certificate in London. Salary £800 rising to £1100 per annum.—Apply in own handwriting, marking the envelope "Application Engineer Surveyor," and "Private and Confidential" to the Chief Engineer, 22, Old Queen Street, Westminster, S.W.1. E7407 A

RESEARCH AND DEVELOPMENT.—Assistant required for work on controls for gas appliances. Age 23–30. H.N.C. or equivalent qualification. Previous experience in similar field desirable but not essential.—Applications with full particulars to Technical Manager, Engineering Division, Evered and Co., Ltd., Surrey Works, Smethwick. E2546 A

RESIDENT ENGINEER required for supervision and inspection of a contract in South Midlands. Experienced in heating, ventilation, piped services and electrical installations. Good references essential.—Write stating age, experience and salary required to Oscar Faber and Partners, Consulting Engineers, 29, Queen Anne Street, London, W.1. E7445 A

SENIOR DESIGN ENGINEER, H.N.C. preferred, knowledge of hydraulics desirable and capable of designing, on own initiative, medium heavy machinery.—Apply Mr. Bedford, Chamberlain Industries, Ltd., Staffa Road, Leyton, E.10, Tel.: LEY 3678. E7371 A

SENIOR DRAUGHTSMAN for progressive firm producing Pressure Vessels and similar equipment for Chemical and Petroleum Industries. 5-day week. Canteen and recreational facilities. Excellent conditions. Staff Superannuation Scheme. Good salary to a fully experienced candidate.—Apply Towler and Son, Ltd., Sugar House Lane, Stratford, E.15. Tel. No.: MARyland 3214. E2548 A

SENIOR DRAUGHTSMAN required for Drawing Office Section engaged on the application of small diesel engines to marine propulsion. Experience on this type of work is essential and technical qualifications an advantage. This will be a secure and well-paid position with excellent conditions of service.—Apply in writing, giving full details, to the PERSONNEL MANAGER, PETTERS LIMITED, Staines, Middlesex. E7424 A

SENIOR DRAUGHTSMAN, age 30 or over, required for Chemical Engineers' Group of Johnson, Matthey and Co., Limited, at their Head Office, for work on chemical plant and services within the company, consisting of design, detail, layout and site supervision, &c. Conditions of service include free lunches, superannuation scheme, profit-sharing bonus scheme and 3 weeks' holiday after 5 years.—Write, giving full details of age, qualifications, experience, &c., to the Secretary, 78, Hatton Garden, London, E.C.1. E7389 A

STRUCTURAL DESIGNER required for work on important and interesting structures of steel lattice construction. Qualifications at least to H.N.C. and good experience in steel construction essential. Age 23 to 27.—Apply, giving all details and salary required to Personnel Officer (Staff), British Insulated Callender's Construction Company, Ltd., 21, Bloomsbury Street, London, W.C.1. E7437 A

TECHNICAL EDITOR required for a new monthly publication of Fuel Abstracts. Qualifications required : Chartered Fuel Technologist or Graduate in Science or Engineering with research or editorial experience in field of Fuel Utilisation. Skill in collating, classifying and indexing essential. ASSISTANT EDITOR, not necessarily graduate, but good typist, also required.—Applications in writing to Institute of Fuel, 18, Devonshire Street, W.1. E7410 A

TECHNICAL REPRESENTATIVE

National firm of building and civil engineering contractors, with offices throughout the country, require additional Technical Representation. The appointment, which is a senior post, will be based on a head office in Lancashire, but will entail travelling throughout the United Kingdom, for which purpose a car will be provided and all out-of-pocket expenses paid. The successful applicant will be paid a salary commensurate with the nature of the duties involved, and will, in addition, participate in generous superannuation benefits. Applications, which will be treated in the strictest confidence, are invited from men engaged in a similar sphere who are in contact with consulting engineers, architects and industrialists at a high level.—Reply, with details of experience, previous engagements and an indication of present salary, to BOX No. E7386, "The Engineer." A

THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION requires a senior ELECTRICAL ENGINEER at their Battersea Research Laboratories. The successful candidate will be required to guide the work of a team in the following fields : the control of heavy electrical machinery ; servo systems and automatic control ; and analogue simulators and their application to problem control. The work is concerned with the application of these fields in effecting improved control in the steel industry and entails a close liaison with actual steelworks conditions.

A degree in Electrical Engineering or equivalent qualification is essential, together with experience in the field of automatic control.

Salary ranges in the scale £1040 by £35 to £1390 as a Senior Scientific Officer according to age, qualifications and experience. The post is superannuated under the F.S.S.U. Written applications only, quoting "E.E.I" to the Personnel Officer, B.I.S.R.A., 11, Park Lane, London, W.1. E7431 A

WORKS MANAGER required for new Factory in Norwich area, engaged in the manufacture of Steel Furniture. Must have held similar position over a period of years and be fully conversant with the manufacture, and fabrication of sheet metal in all its aspects, on a "flow production" basis. Only those with above qualifications coupled with good administration, initiative, and drive, need apply. Good salary and working conditions. Pension Scheme in operation.—Write in confidence to Works General Manager, Roneo Works, Romford, Essex. E7404 A

Classified Advts. continued on page 162

COMPANY MEETING

POWELL DUFFRYN LIMITED

The annual general meeting of Powell Duffryn Limited was held on September 16th in London, Sir Henry Wilson Smith, K.C.B., K.B.E. (the Chairman) presiding.

The following is an extract from his circulated statement :—

Trading profits in 1958–59, after depreciation but before tax, were £1,513,000, a reduction of £318,000 on the previous year.

The Group's net profit after tax is very much the same as in the year before—£1,076,000 compared with £1,064,000 in 1957–58.

The general background to the fall in trading profits is to be found in the unfavourable conditions which have affected coal and shipping activities throughout the year. Coal and shipping taken together, still account for more than half of Group profits, so that we remain vitally concerned in their state of health.

GROUP ACTIVITIES

STEPHENSON CLARKE itself was much affected by the fall in seaborne coal tonnage and especially by the changing pattern of supplies for the electricity and gas industries. A number of our older coal carrying ships have been disposed of and the Company is now equipped with a fleet of the most modern and efficient design.

An event of major interest was the first importation into this country of liquid methane for the Gas Industry, thus implementing plans laid and carried through by that industry in co-operation with American partners. The ship in question, the *Methane Pioneer*, is managed and operated on behalf of its owners by Stephenson Clarke.

ASSOCIATED COAL & WHARF COMPANIES LIMITED, in which the Group holds a controlling interest, once again had a good year.

The results of the CORY BROTHERS' Companies present a chequered pattern but do include some bright spots. Despite current difficulties, earnings from shipping activities—as agents, charterers and brokers—still produce a useful income. Oil storage activities continue to develop satisfactorily.

The timber interests of the Group have been consolidated under P.D. TIMBER INDUSTRIES LIMITED. A year ago, I said that 1957 was not an easy year for the timber business. 1958 was even more difficult. Yet our home companies importing timber and our overseas companies exporting timber succeeded in making reasonable profits.

At home, J. R. Gordon Limited, aided by a substantial reorganisation, has shown definite signs of improvement in its business. On the other hand, its principal investment—the insulation board mill at Queensferry, North Wales—has continued to be disappointing.

That CAMBRIAN WAGON & ENGINEERING COMPANY LIMITED failed to equal its record results of 1957–58 was entirely due to the policy and practice of the British Transport Commission. The repairing of railway wagons, at points other than the Commission's own workshops, has been severely cut and the building of new wagons is almost at a standstill. Faced with the present situation, Cambrian has accelerated its non-railway activities and to mark the alteration in the pattern of its trading, its name has been changed to "POWELL DUFFRYN ENGINEERING COMPANY LIMITED." The Company, whilst still remaining specialists in all forms of railway rolling stock, has established itself in the manufacture of tanks and related equipment for the petroleum, chemical and allied industries, and in a wide field of heavy precision and structural engineering. In addition, this Company has become the sole licensed manufacturers within the United Kingdom for the complete range of mobile materials handling equipment of Dempster Brothers of the United States.

POWELL DUFFRYN CARBON PRODUCTS has had an interesting and encouraging year on the preparatory stages of its programme for machining Nuclear Graphite. It has received new orders for work in connection with the atomic power programme in addition to the work already entrusted to it by the General Electric Company for the Hunterston Station in Scotland. Since the end of the financial year, these contracts have come into production and will keep the Company occupied well into 1961. This type of work can only be obtained at keen prices, but I am confident that with its modern and efficient machine shop this Company will make a useful contribution to Group results.

Our wide connections with the Heat and Power industries convince us that we should develop as much as possible our interests in the heating and allied trades—including ventilating and air conditioning.

WEATHERFOIL HEATING SYSTEMS—pioneers in this country in Warm Air Heating—has, since it became a member of the Powell Duffryn Group some years ago, greatly widened its activities.

RHYMNEY ENGINEERING LIMITED, owned jointly by International Combustion and Powell Duffryn, has found it difficult to expand its main business, which is with the National Coal Board. The current order book is, however, in reasonable shape, and I hope for better results from this Company in the period ahead of us.

POWELL DUFFRYN TECHNICAL SERVICES LIMITED has maintained its high reputation both in this country and overseas.

The development and expansion of activities which are appropriate both to us as a Group and to the unfolding pattern of industrial and commercial progress remains the main plank of your Board's policy and is well within our compass.

The report and accounts were adopted.

SITUATIONS VACANT

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, "The Engineer." A

WEST MIDLANDS GAS BOARD
ASSISTANT
WORK STUDY OFFICER

Candidates, who should possess a sound engineering background, must be experienced in work measurement and method investigation and fully conversant with latest techniques. A thorough knowledge of process charting is required. The location will be within the Birmingham area.

The salary for the appointment, which is pensionable and subject to medical examination, will be in accordance with Group A (£1155–£1235 per annum) of the National Salaries Table for Senior Gas Officers.

Applications, stating age, qualifications and full details of experience, together with the names of two referees, should be addressed to the Industrial Relations Officer, West Midlands Gas Board, 6, Augustus Road, Edgbaston, Birmingham, 15, to reach him not later than the 9th October, 1959.

J. SWAN,
Secretary to the Board.

E7397 A

SITUATIONS VACANT

BRITISH RAILWAYS
(Southern Region)

require a

DEVELOPMENT ASSISTANT

in the London Area

Applicants must have a good knowledge of railway electric traction machines and control equipment, the proof testing of which under service conditions will be the primary duty. Familiarity with testing techniques and equipments is also required. Knowledge of principles of coach running and brake equipment will be advantageous. Minimum qualification required is Graduateship I.E.E. or I.Mech.E.

Salary range £1045/£1150.

Application forms may be obtained from the Chief Mechanical and Electrical Engineer, British Railways, Southern Region, 15, St. Thomas Street, London Bridge, S.E.1.

E7388 A

SITUATIONS VACANT

THE GENERAL ELECTRIC COMPANY LIMITED

ATOMIC ENERGY DIVISION

Invites applications for a position in their Structural Development Laboratory at Erith.

Applicants should be University Graduates with an interest in structural test work. Previous experience of this type of work is desirable, though not essential. It will be the duty of the successful candidate to design and order all necessary test components, carry out liaison and supervision of the drawing, construction and testing of rigs and to report on the test results.

Applications are also invited for Mechanical or Structural Honours Graduates interested in the basic design and analysis of complex steel structures, stress analysis of shells, evaluation of temperature stress distributions, mechanical vibrations, and pipework calculations. Previous experience of some aspects of this work is desirable, though not essential.—Apply Personnel Manager (DWB/10), The General Electric Company, Limited, Erith, Kent.

E7411 A

SITUATIONS VACANT

GRADUATE MECHANICAL ENGINEER

A large progressive Company in the Manchester area desires to recruit a Graduate MECHANICAL ENGINEER, preferably with 3–4 years' practical experience.

It is intended that the duties will initially comprise investigational work in relationship to Steam and Power distribution and efficiency. This will be followed by further investigational work on the efficiency of Mechanical Plant. Thereafter additional promotional prospects are envisaged.

Good commencing salary, employee benefit scheme.

Applications, giving details of age and experience should be addressed to BOX No. E7396, "The Engineer."

A

CENTRAL ELECTRICITY GENERATING BOARD
NORTHERN PROJECT GROUP

require

THIRD ASSISTANT ENGINEER (CIVIL)

based in the first instance at

TRAWSFYNYDD NUCLEAR POWER STATION PROJECT

Salary range :
£1090 by £30 to £1300 per annum.

The successful candidate will be required to undertake duties covering all aspects of civil engineering work found on modern power station sites including normal levelling and surveying and preparation of plans. This appointment is ideally suited to a young graduate seeking site experience. A degree in civil engineering or membership of an appropriate professional institution will be an advantage.

Application forms (A.E.6), available from the Administrative Officer, Northern Project Group, Central Electricity Generating Board, Agecroft Road, Pendlebury, Swinton, Manchester, to be returned by 28th September, 1959.

Envelopes marked "Confidential—Staff Vacancy." E7435 A

RICHARDSONS WESTGARTH (HARTLEPOOL) LIMITED.

SENIOR ENGINEER

Applications are invited for a senior commercial appointment with Richardsons Westgarth (Hartlepool), Ltd., at Hartlepool. This is an important post for which the successful candidate will require to have a sound knowledge of steam turbine and associated plant for Power Station and industrial applications, from both the technical and commercial aspects, a personality which commands confidence together with administrative ability.

Candidates should hold a University degree. Knowledge of the export market together with experience with Consulting Engineers will be of considerable advantage.

This appointment will carry a substantial salary, commensurate with the qualifications and experience of the successful applicant.

Contributory Pension Scheme in operation. Housing assistance available.—Write, in confidence, to the Group Personnel Officer, Richardsons Westgarth and Co., Ltd., P.O. Box No. 2, Wallsend, Northumberland, quoting reference No. H.48B. E7428 A

CENTRAL ELECTRICITY GENERATING BOARD

TRANSMISSION DEPARTMENT

TRANSMISSION CONSTRUCTION BRANCH

Due to an increase in the scope of the work of the Branch, applications are invited for the appointment of a number of SECOND ASSISTANT CIVIL ENGINEERS in the Civil Engineering Sub-Branch at Headquarters, London, S.E.1.

Candidates should preferably be Corporate Members of one of the recognised Engineering Institutions and/or hold a University Degree in Civil Engineering.

The duties are concerned with the design and construction by contract of the civil engineering and building work required in connection with the establishment or extension of high-voltage sub-stations.

Salaries within the scale £1,245–£1,605 p.a.

Applications stating age, qualifications, experience, present position, and salary, to the Personnel Officer, 24/30, Holborn, London, E.C.1, by 9th October. Envelopes should be marked "Confidential Ref. ENR/373."

E7430 A

ENGLISH ELECTRIC
ATOMIC POWER DIVISION

Whetstone Near Leicester

A number of openings arise for

MECHANICAL ENGINEERS

in particular we wish to appoint

AN AERODYNAMICIST with some considerable knowledge of Gas Dynamics as applied to problems of Compressible Flow, Thermodynamics and Heat Transfer. The successful applicant will spend a large proportion of his time on the initiation and development of new projects.

A THERMODYNAMICIST who would tackle a variety of Thermodynamics and Heat Transfer problems in the investigation and feasibility study of steam cycles for nuclear power stations.

DEVELOPMENT ENGINEERS to undertake research and development work largely related to seals, bearings and lubrication problems and also on the development and testing of models and prototypes.

PLANNING ENGINEERS responsible for programming, planning and co-ordinating construction work. Openings exist for both mechanical and electrical engineers who have had experience in a similar capacity on the construction of power stations or heavy chemical plant.

The qualifications for these appointments will range from H.N.C. to a good honours degree or its equivalent and experience appropriate to the particular appointment is desirable.

Please write, giving details of qualifications and experience, to Dept. C.P.S., Marconi House, 336/7, Strand, London, W.C.2, quoting reference E 1817L.

E7444 A

ENGINEERS

required by

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKS

to integrate production requirements in a wide field of metallurgical, chemical and plastics work into a co-ordinated programme and to progress the work of various manufacturers of scientific and research equipment.

A broad knowledge of all aspects of production is required and Corporate Membership of a senior engineering institution or equivalent qualifications.

SALARY : £1345 to £1800.

Contributory superannuation scheme. A house or substantial assistance with house purchase will become available for married officers living beyond daily travelling distance.

POSTCARDS for application forms to the Senior Recruitment Officer, at above address. Please quote reference 2418/25.

E7429 A

Opportunities for

GRADUATE ENGINEERS

in

CHEMICAL, MECHANICAL AND ELECTRICAL ENGINEERING

An Engineering-Contracting Company with a record of expansion over the past years requires a number of engineers for enlargement of their Design Office to undertake additional Petroleum Refinery and Petrochemical projects.

Applicants, between the ages 24–30 years, should preferably be currently engaged in design, operating, or other technical phases of refinery, chemical plants, or other similar installations such as power plants, gas works, etc.

These appointments offer interesting work in engineering design with attractive future prospects and are available to highest calibre men with post-graduate experience who are seeking to broaden their experience and prospects for advancement.

Starting salaries will be in the range from £1400–£1800, depending upon the age and experience of the candidate. Assistance will be given towards expenses of removal. Other benefits include contributory pension scheme, luncheon vouchers, etc.

The Company's offices are located in the West End of London.

Applicants should write, giving details of their age, background and experience, to BOX No. E7443, "The Engineer."

A

SITUATIONS VACANT

ENGINEERS & DESIGN DRAUGHTSMEN

Resulting from our expanding development programme in the Field of Printing Machinery and Mechanical Handling Equipment, we are seeking ENGINEERS & DESIGN DRAUGHTSMEN as follows :

ELECTRICAL ENGINEERS
to prepare control schemes for materials handling projects and printing machines. Experience of small to medium power installations including uniselector and relay techniques essential. H.N.C. or equivalent.

ELECTRO-MECHANICAL DESIGN DRAUGHTSMEN
required to work on Industrial Control Circuits in the Materials Handling and Printing Machinery fields. Previous experience in a similar capacity an advantage. O.N.C. standard or above.

MECHANICAL DESIGN DRAUGHTSMEN
required to design special purpose equipment for Mechanical Handling and development of Printing Press Mechanisms. O.N.C. Standard or above.

Write in confidence, giving full details of qualifications and experience, to : Personnel Manager, Western Manufacturing (Reading), Ltd., The Aerodrome, Woodley, Reading, Berks.

E7421 A

SITUATIONS VACANT

CHEMICAL ENGINEER
FOR
PRODUCTION MANAGEMENT

BROWN & POLSON, LTD.,
Trafford Park, Manchester, 17.

require a CHEMICAL ENGINEER with a degree, or equivalent qualification, for a Production Management appointment. The factory is modern and expanding, operating large-scale Batch and Continuous processes.

The position offers good promotional prospects for a candidate 28–35, having had five years' management experience in a process chemical industry.

Good commencing salary and employee benefit schemes. Applications, in some detail, should be addressed to the Personnel Adviser.

E7393 A

SITUATIONS VACANT

DEVELOPMENT ENGINEER

A mathematician with engineering degree is required for work on mechanical and stress problems associated with large electric motors, water turbines and pumps, and for the development of new designs.

The commencing salary is in the region of £900 per annum but this would be increased for a successful candidate having practical experience of the type of plant under consideration.

Applications should be addressed to the Chief Draughtsman, HARLAND ENGINEERING COMPANY, LTD., B.E.P. Works, Alloa.

E7438 A

SITUATIONS VACANT

PLANT DRAUGHTSMAN

required by

W. H. ALLEN SONS & CO. LTD., BEDFORD,

for Works Engineer's staff, experienced in design of industrial building machinery foundations, structural steelwork, &c. Age 25-35. Qualifications should, for preference, include H.N.C. or equivalent.

Applications, in writing, to the PERSONNEL MANAGER, Queens Engineering Works, Bedford.

E7441 A

CENTRAL ELECTRICITY GENERATING BOARD

SENIOR AND ENGINEERING DRAUGHTSMEN

Applications are invited for appointments as SENIOR AND ENGINEERING DRAUGHTSMEN in the Drawing-Office of the RESEARCH LABORATORIES, LEATHERHEAD, SURREY.

(a) **Mechanical Draughtsmen**—for a wide range of work, including the general design and layout of Laboratory test rigs and prototype apparatus. For one of the posts experience of pressure vessel and pipework design will be an advantage.

(b) **Electrical Electronic Draughtsmen**—for the preparation from circuit diagrams of diagrammatic and working chassis layouts, and wiring diagrams for prototype electronic and light electrical equipment. Familiarity with Interservice Standards and Specifications for electronic equipment would be an advantage.

Previous laboratory experience is not essential but an important factor will be adaptability.

Salaries for Senior Draughtsmen will be on a scale within the range £790–£1030 p.a., according to duties and responsibilities, and for Engineering Draughtsmen within the range £620–£740 p.a.

Applications stating age, qualifications, experience, present position and salary to the Personnel Officer, 24/30, Holborn, London, E.C.1, by 5th October. Envelopes should be marked "Confidential Ref. ENR/371."

E7403 A

MECHANICAL HANDLING

Project and Production

DESIGNERS

with extensive experience on Bulk Material Handling Plant and Equipment, required by well-known progressive Company in the North Midlands, serving Coal, Quarry, Oil, Gas and Chemical Industries.

The men we are looking for will be first and foremost Structural Designers used to Stress work, coupled with familiarity with designs of Crushing, Screening, Conveying and Bulk Handling of Materials and Fluids.

They will be at least H.N.C. standard, will have initiative and already be earning in the region of £900–£1000.

Applicants with proved ability will be invited for early interview, for which expenses be paid.

Write, giving full chronological details of experience, &c., to BOX No. E7406, "The Engineer."

A

RONEO LIMITED

require DRAUGHTSMEN, both Design and Detail for their programme of expansion in the manufacture of Steel Office Equipment.

Vacancies exist for :

2 Design Draughtsmen, experienced, qualified and capable of development work in this field

and

4 Detail Draughtsmen, with experience preferred, but applications will be considered from Detailers willing to apply their knowledge and skills.

A Pension Scheme, good working conditions, and salary commensurate to ability are offered.—Please write, giving full details of age, experience, qualifications, &c., to the Personnel Manager, Roneo Works, Romford, Essex.

E7291 A

SMITHS MOTOR ACCESSORY DIVISION

DESIGNERS

The Motor industry continues to expand—why not grow with it, in London, away from the Midland areas which are over-dependent on the internal combustion engine for their prosperity ? The Design Department of the Company's Motor Accessory Division has figured prominently in the terrific progress made in recent years in this side of the industry, and now a fresh influx of DESIGNERS with new ideas is urgently required to exercise their ingenuity and resourcefulness on new instruments and mechanisms.

This advertisement should only concern natural designers (i.e. those who can, not those who think they can, design), probably in the 30–40 age range, with an H.N.C. and, of course, several years' experience. If your qualifications are greater than this, the prospects are even better, but in any case, if this advertisement interests you, please write a letter of application to :—

The Staff Manager,
S. SMITH & SONS (England), LTD.,
Cricklewood, London, N.W.2.

and quote reference SM 238.

E7394 A

"VSG" HYDRAULICS

VICKERS-ARMSTRONGS (ENGINEERS), LTD., WEYMOUTH, DORSET

DESIGN DRAUGHTSMEN required. Preference given to those having experience of hydraulic systems and power transmission, and holding H.N.C. (Mechanical). Also two vacancies for ELECTRO-MECHANICAL DRAUGHTSMEN.

Contributory Pension Scheme and Sports Club facilities.

Apply by letter in first instance, giving full details of experience and salary required.

E7285 A

THE DISTILLERS COMPANY LIMITED

INSTRUMENT DRAUGHTSMEN

The Distillers Company, Limited, have a vacancy at their Devonshire House, Engineering Office, in the West End, for a male Instrument Draughtsman. Candidates, aged between 25 and 40, must hold a Higher National Certificate in Electricity. They should also have considerable experience in design and drawing of instrumentation of automatic control installations, preferably for chemical or plastics plants.

Write :
STAFF MANAGER,
THE DISTILLERS COMPANY, LIMITED,
21, ST. JAMES'S SQUARE,
LONDON, S.W.1.
Quote Ref. 96/59.E.

E7390 A

British Titan Products Co Ltd

have vacancies for

MECHANICAL ENGINEERS

at their Grimsby and Billingham Factories.

The Company is primarily concerned with the manufacture of Titanium Dioxide and is characterised by a tenfold expansion in post-war years. This continuing expansion offers plenty of scope for Engineers in the fields of Plant, Maintenance, Construction and Design. The current vacancies are for Maintenance and Construction work with opportunities later in the Design field.

Preference will be given to candidates with a University Degree in Mechanical Engineering, but those with an equivalent professional qualification will also be considered. Post-graduate apprenticeship is essential and the upper age limit for the appointments is 30.

Salaries and prospects are very attractive for men with the right qualifications. Annual bonus scheme and non-contributory endowment assurance and assistance for married men with house purchase and removal expenses.

Applications, in strictest confidence, to be addressed to the
Personnel Manager,
British Titan Products Company, Limited,
Billingham, Co. Durham, quoting reference S.4.

E160 A

DEPUTY TO ENGINEERING DIRECTOR

A small but expanding company situated in the South of England and engaged in the manufacture of capital goods of a general engineering nature, wishes to appoint a deputy to the Engineering Director, to whom he will be responsible for all technical activities.

Candidates should at present be occupying senior executive positions, and should have first-hand experience in the design of medium heavy mechanical handling equipment and steel structures, and should be competent to negotiate at the highest technical levels.

The necessary qualifications include a good mechanical engineering degree, and considerable technical and administrative experience.

Preferred age range 35 to 45. A commencing salary of not less than £2500 will be paid, considerably more to a very experienced man. Other benefits appropriate to a senior position.

Reply in confidence, to BOX No. E7440, "The Engineer."

A

Classified Advts. continued on page 164

SITUATIONS VACANT

SENIOR MECHANICAL DESIGN ENGINEER

An Engineer with a degree or equivalent qualification is required to work alongside people engaged in materials research. His function will be the design of specialised materials and apparatus, the construction of mechanical and electro-mechanical devices, laboratory scale plant and neo-mechanisms.

This is an interesting appointment with good prospects with a Research Unit in a pleasant part of the Midlands.

Apply: BOX No. E7449, "The Engineer." A

SITUATIONS WANTED

STRUCTURAL ENGINEER seeks appointment in Midlands area. Twenty-five years' experience in responsible positions, including Chief Draughtsman, Chief Designer, Technical Manager. Would consider any Senior position offering scope.—BOX No. E2544, "The Engineer." B

PARTNERSHIPS

CHARTERED STRUCTURAL AND CIVIL ENGINEER, over 30 year's experience, Consultant to large organisation, seeks Partnership or Directorship. Probationary period if desired. Capital available. Mobile.—BOX No. E2552, "The Engineer." C

PATENTS

NOTICE IS HEREBY GIVEN that AJAX MAGNETHERMIC CORPORATION seeks leave to amend the Complete Specification of Letters Patent No. 742,856 for an invention entitled "ELECTRIC INDUCTION HEATER."

Particulars of the proposed amendments were set forth in the Official Journal (Patents), No. 3683, dated September 16th, 1959.

Any person may give Notice of Opposition to the amendment by leaving Patents Form No. 36 at the Patents Office, 25, Southampton Buildings, London, W.C.2, on or before October 16th, 1959.

GORDON GRANT,
Controller General.

E2553 H

SUB-CONTRACTING

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process; sample castings treated; A.I.D. approved.—Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone: Knottingley 2743/4). E116 MW

CENTRE LATHES:
Up to 14ft. 0in. dia. by 44ft. 0in. long.
VERTICAL BORING:
Up to 15ft. 7in. dia. by 8ft. 0in. high.
HORIZONTAL BORING:
Up to 8in. spindle, 40ft. 0in. by 20ft. 0in. table.
PLANING:
Up to 34ft. 0in. long by 11ft. 11in. wide by 8ft. 0in. high.
PLANO MILL:
Up to 14ft. 0in. long by 6ft. 6in. wide by 5ft. 6in. high.
SHAFT GRINDING:
Up to 23ft. 0in. long by 2ft. 0in. dia.
SLIDEWAY GRINDING:
Up to 7ft. 0in. long by 4ft. 0in. high by 2ft. 0in. wide.
VERTICAL SPINDLE GRINDING:
Up to 11ft. 0in. long by 1ft. 9in. high by 2ft. 0in. wide.

HARVEY

G. A. HARVEY & CO. (LONDON) LTD., WOOLWICH ROAD, LONDON, S.E.7.

E7256 MW

FOR HIRE

BELLMANS MASTS FOR HIRE, to lift from 1 to 20 tons, 30ft. to 150ft. Blocks and tackle. Hand-operated winches. From £1 per day.—BELLMAN'S (Phone: SLOane 5259), Hobart House, Grosvenor Place, S.W.1. E103 K

MISCELLANEOUS

MOBILE LIFTING SERVICES.—Lump sum or Hire Rate Quoted for any Lifting Work by Lorry-Mounted or Crawler Cranes, any size, any area.—TARSLAG, LTD., Rotherham 3235. E1616 I

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WEYBRIDGE. Small, equipped, precision engineering works for sale Freehold. Floor space 2700 sq. ft. Might let building on lease.

FULHAM, S.W. 33,500 sq. ft. Post-war factory most suitable for engineering. Oil-fired heating, good offices. For sale Freehold.

Richards and Partners, 3, Arundel Street, W.C.2 (TEM 7471). E7398 L

BUSINESS OPPORTUNITIES

REMPLOY SPONSORSHIP SCHEME.—Send for details which show an attractive proposition to manufacturers.—Write to the Managing Director, Remploy, Ltd., 25–28, Buckingham Gate, S.W.1, or telephone VICtoria 6621 (12 lines). E155 O

ADVERTISER, PRIVATE INVESTOR desires to purchase whole or part interest in concern under progressive management making annual net profit of £15/50,000.—BOX No. E163, "The Engineer." O

TO ENGINEERING GROUPS.—Ultra Modern Foundry producing HIGH-GRADE GREY IRON CASTINGS, capacity 200 tons weekly. Would consider amalgamation and/or co-operation. Asset value of freeholds and plant approximately £150,000/£200,000.—BOX No. E165, "The Engineer." O

ENGINEERS with capital willing to purchase controlling interest in Company manufacturing engineering specialities. Replies will be treated in strictest confidence. Reply.—BOX No. E7364, "The Engineer." O

ENGINEER with business experience has capital available to Develop and Market New Invention having wide field of application. Send full details in strict confidence.—BOX No. E2554, "The Engineer." O

FOR SALE

SERVICE EDWARDS VALUE!

SCHULER Power-Geared Open-Fronted Inclinable Cam Action Double Action Drawing Press with adjustable bed, spring balanced blankholder, punch stroke 11in., blankholder stroke 4½in., bed 24½in. by 14½in.

TWO NEW BFSCO Type F., 80½in. by 14 Gauge Hand-Operated Universal Swing Beam Folding Machines, with high lift clamping beam and adjustable bed, smallest trunk section formed 11in. by 9½in., maximum working length 80½in., capacity mild steel 18 S.W.G., height of lift of clamping beam 6in.

WESTON Model 400/100, Double-Sided Friction Screw Press, of welded steel plate construction, arranged motor drive for 400/3/50, pressure exerted approximately 120 tons, maximum stroke 11in., diameter of screw with four starts 6½in., size of bed 21½in. by 18in., weight approximately 5 ton 8 cwt.

NEW BRUECK Type 20/1600, All Steel Motorised Press Brake, motorised for 400/440/3/50, maximum pressure 20 tons, forming capacity 63in. by ¼in. approximate weight 36 cwt.

TAYLOR AND CHALLEN Power-Operated Circle Cutting Machine, motorised for 400/440/3/50, capacity 16 S.W.G. mild steel, cuts circles from 7in. to 52in. diameter, weight approximately 8 cwt.

RUSHWORTH Power-Operated Double-Geared Open-Ended Guillotine Shearing Machine, Overcrank type, arranged motor drive for 380/440/3/50, capacity mild steel 4ft. by ¼in., gap in open ends 6½in., weight approximately 50 cwt.

NEW MUBEA All Steel Construction Bar and Angle Shear, arranged motor drive for 400/3/50, capacity round bars 2in., square bars 2in., flat iron 10in. by ½in., 5½in. by 1in., angles up to 4in. by ½in., 5in. by 0·425in., tee iron 5in., beams 6in., channels 6in., length of blades 12½in.

Photographs of the above are available.

Very favourable Hire Purchase terms can be obtained.

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Of Every Description. Attractive Prices.

F. J. EDWARDS LTD.,

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LONDON, N.W.1.
Telephone: EUSton 4681–3771
and at
LANSDOWNE HOUSE, 41, WATER STREET,
BIRMINGHAM, 3.
Telephone: Central 7606–8. E207 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft., and 30ft. wide huts; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent (Tel.: Bexleyheath 305). E113 G

FOR SALE

FRED WATKINS (ENGINEERING) LTD.

STEAM BOILERS.—Cochrane Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia. 100/150 lb. w.p.; reconditioned 8ft. 6in. down to 3ft. dia.; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p., 300 reconditioned Vertical Crosstube, all sizes.

AIR COMPRESSORS.—Two Belliss & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised; and several others of various makes and capacities.

200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 200 h.p.

MOBILE ROAD CRANES.—10-ton Lorain lorry mounted 30ft.–70ft. extendible jib; 10-ton 33 R.B. track mounted, 40ft. jib; 8½-ton Ransomes Diesel/Electric, 21ft. jib; 6-ton Coles Diesel/Electric, pneumatics, new 1948 (2); 6-ton Coles Diesel/Electric, solids; 4-ton Coles Diesel/Electric, solids; 1945; 4-ton Jones K.L44, diesel, 1950; 3-ton Jones "Super 40" diesel, pneumatics (3).

OVERHEAD CRANES.—40-ton Babcock, 40ft. span, 400/3/50, "Goliath"; 30/5-ton Adamson, 42ft. 3in. span, 400/3/50; 20/6-ton Vaughan, 42ft. 3in. span, cab type (6); 20-ton King, 42ft. 3in. span, 400/3/50; 15-ton Morris, 35ft. span, hand-operated; 10-ton Morris, 45ft. span, 36ft. lift; 10-ton Morris "Goliath," 40ft. span, 400/3/50; 10-ton Vaughan, 23ft. 6in. span, 400/3/50; 10-ton Vaughan, 21ft. span, 44ft. lift, 7½ tons; Wharton, 25ft. span, 400/3/50; 5-ton Henderson, 24ft. 7in. span, 1946; 5-ton Morris, 58ft. span, hand-operated; 5-ton Royce, 2-motor crab, 440/3/50; 5-ton King, 29ft. 3in. span, power hoist, hand travel; 5-ton Morris, 28ft. 6in. span, power hoist, hand travel; 4-ton Morris, 19ft. span, 220V, d.c. (3); 3-ton Adamson, 48ft. span, 400/3/50; 2-ton Adamson, 34ft. span, 400/3/50 (2); 2-ton Morris, 18ft. span; 2-ton Vaughan, 27ft. 6in. span, 2-motor; majority of the above are unused.

DERRICK CRANES.—7-ton Rushworth, hand, 30ft. jib; 5-ton Wilson, Electric, 70ft. jib; 5-ton Butters, hand, 45ft. jib; 1½-ton Anderson Grice, hand, 40ft. jib.

RAIL CRANES.—18-ton Brownhoist, steam, 50ft. jib; 10-ton Coles, steam, 40ft. jib; 10-ton Grafton, 34ft. jib, diesel conversion; 8-ton Wilson, steam, 35ft. jib; 5-ton Grafton, 35ft. jib, diesel conversion; 5-ton Smith, 50ft. jib (2); 5-ton Cowans Sheldon, 50ft. jib.

LOCOS.—Fowler diesel, 150 h.p. (2); Ruston diesel, 80/88 h.p., new 1942; Bagnall 14in. by 22in., two oil-fired, one coal; Peckett, steam, 7in. by 12in., 1941; also 3 miles track, 24in. gauge, Bogies, Turnouts, &c.

STEEL PIPING.—50,000ft., 2in. Galvanised, new; 60,000ft. 3in. black, new; 5000ft., 8in. seamless; 1000ft., 12in. seamless; 500ft., 14in. seamless; 400ft., 18in. riveted; 280ft., 21in. o.d. welded flanged; 3800ft., 21in. seamless flanged; 500ft., 24in. riveted; 1450ft., 27in. o.d. welded flanged; 216ft., 48in. riveted; 216ft., 60in. riveted.

CAST IRON PIPES.—Large stocks all size up to 24in. flanged and s.s. Immediate delivery.

VALVES.—Exceptional Surplus Ministry Lot. New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock all sizes, Parallel Slide Sluices, Gunmetal, Reducing and Check Valves. List on request.

STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.

MACHINE TOOLS.—Scriven Plate Bending Rolls, 14ft. by ¾in.; Robertson Straightening Rolls, 8ft. 6in. by ¾in.; Berry Bending Rolls, 7ft. by ¾in.; Tangye 200-ton Hydraulic Vertical Straightening Press, 15ft. by 3ft. table; Herbert 3ND Miller, 61in. by 15in. table; Pels Punch and Shears, ¾in. capacity; nine new 2 cwt. and 1 cwt. Pneumatic Hammers; Bliss 14T Tapering Press; Bonn Hydraulic Tube Bender up to 20ft. by 4in. bore; 100-ton Bigwood geared Bending and Straightening Machine up to 12in. by 6in. R.S. Joists; two 40kVA Spot Welding Machines; Wire Drawing Machine, 3 die up to ¾in. copper; 50kW Electric Furnace 1000 deg. Cent., chamber 54in. by 30in. by 21in.

SLING ENGINEERING WORKS
COLEFORD, GLOS.
'Phone: Coleford 2271/2. E106 G

U.L.R.O. 16in. by 30in. B.C. S.S. and S.C. Taper Turning, Twin Saddles, Mtd., Lathe.
WEATHERLEY Oilgeared Cyclomatic Broaching Machine, Model XM.80, 30in. stroke, as NEW.
HASENCLEVER 100-ton, 14in. stroke, Hor. Power Press.
BARNES Vert. Hydram Hyd. Drilling, Boring and Reaming Machine, 4in. cap., 36in. stroke, 30 h.p.

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E7420 G

ONE VERTICAL MULTI-TUBULAR THERMAX BOILER. Size No. 45, by Ruston and Hornsby, Ltd., 15ft. high by 6ft. 6in. dia., fitted with skirt to make suitable for operation with Underfeed Stoker. Working pressure 100 lb. per square inch.—Write: 1591, Wm. Porteous and Co. Glasgow. E7399 G

15 CWT. PNEUMATIC HAMMER by Ross. Had little use.—BOX No. E7427, "The Engineer."

FOR SALE.—Permutit Base-Exchange Water Softening Plant consisting of Two Units, each capable of 12,000 gallons of water from 22 G.P.G. total hardness, 3000 G.P.H. maximum flow.

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600

ECONOMIC BOILERS

TWO—COCHRAN "SINUFLO" double pass, 10ft. 9in. diam. × 15ft. 8in. over tubeplates; evap. 16,800/18,000 lb./hr.; 120 p.s.i., with chimney, induced draught fans, Thermofeed controls.

ONE—JOHN THOMPSON self-contained, 11ft. diam. × 16ft. over tubeplates; 120 p.s.i., evap. 14,500/15,150 lb./hr., with fittings and I.D. fan

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TWO—JOHN THOMPSON self-contained treble pass super economic, 9ft. 6in. diam. × 14ft. over tubeplates; 120 p.s.i.; 9500 lb./hr., with fittings, I.D. fan.

All Suited for Coal or Oil Firing.

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E202 G

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For Sale—38" diameter Electro Magnet and control gear with a 5 kW self-contained Generator powered by a Petter AVA2 Diesel Engine, suitable for Mobile Crane or Excavator.

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METAL PLANING MACHINE

Capacity 40ft. by 8ft. by 7ft.

Will become available shortly.

Drive is by motor and electro-magnetic clutch, or by a Ward-Leonard a.c./d.c. Generator Set, total h.p. 130, which is new and not yet installed. The Planer is equipped with four toolheads in all, two on the cross rail, one on the right-hand column and one a left-hand special side standard. Cutting speed up to 50ft. with existing drive or up to 180ft. with the new set. The condition of this Planer is sound throughout.

Will interested parties write for further details to BOX No. E7432, "The Engineer."

G

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E7387 G

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Fielding 200-ton, ditto, 3ft. stroke, with pumps and motors (5 available).
Fielding 100-ton ditto, 4ft. to 5ft. stroke, with pumps and motors.
Two 73ft. 4in. by 5ft. Kilns or Dryers, with Crofts Reduction Gear and 27 h.p. motor.
Two 26ft. by 4ft. Rotary Cooler or Dryers, with reduction gear and motor.
Available at low prices ex present sites to save cost of bringing into stock.

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COLEFORD, GLOS. E151 G

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By Order of the Minister of Supply

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		Main Location	*Auctioneers*
September 29-30	Machine tools and miscellaneous stores.	M.O.S. Storage Depot, Byley, Nr. Middlewich, Cheshire. (Sale at Cheetham Town Hall, Cheetham, Manchester, 8.)	J. H. NORRIS & SON (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)
October 2	Miscellaneous stores.	Returned Stores Group, Reed Hall, Colchester, Essex.	FENN, WRIGHT & CO. (Dept. L), 146, High Street, Colchester, Essex. (Tel.: 3171.)
October 9	Vehicles and miscellaneous stores, including : load carriers ; trailers ; motor cycles ; M.T. spares for British and American vehicles ; tyres and tubes ; lathes and lathe chucks ; milling machine ; crane and railway engine spares ; air compressors ; charging sets ; generators ; copper cable and wire ; telephone and electrical equipment ; steel binning and racking ; steel cabinets ; flexible hose ; weighing machines ; kitchen equipment ; tables ; cupboards ; leather cases ; canvas covers ; signal satchels ; telescopes ; etc.	Central Ordnance Depot, Bicester, Oxon.	MIDLAND MARTS, LTD. (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73.)
October 14	Miscellaneous stores.	Northern Command Ordnance Sub-Depot, Barlow, Nr. Selby, Yorks.	BARTLE & SONS (Dept. L), 50-52, Merrion Street, Leeds, 2. (Tel.: 2.0898.)
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October 27-29	Machine tools and miscellaneous stores.	M.O.S. Storage Depot, Royal Arsenal, Woolwich, S.E.18	FULLER, HORSEY, SONS & CASSELL (Dept. L), 10, Lloyd's Avenue, E.C.3. (Tel.: Royal 4861.)

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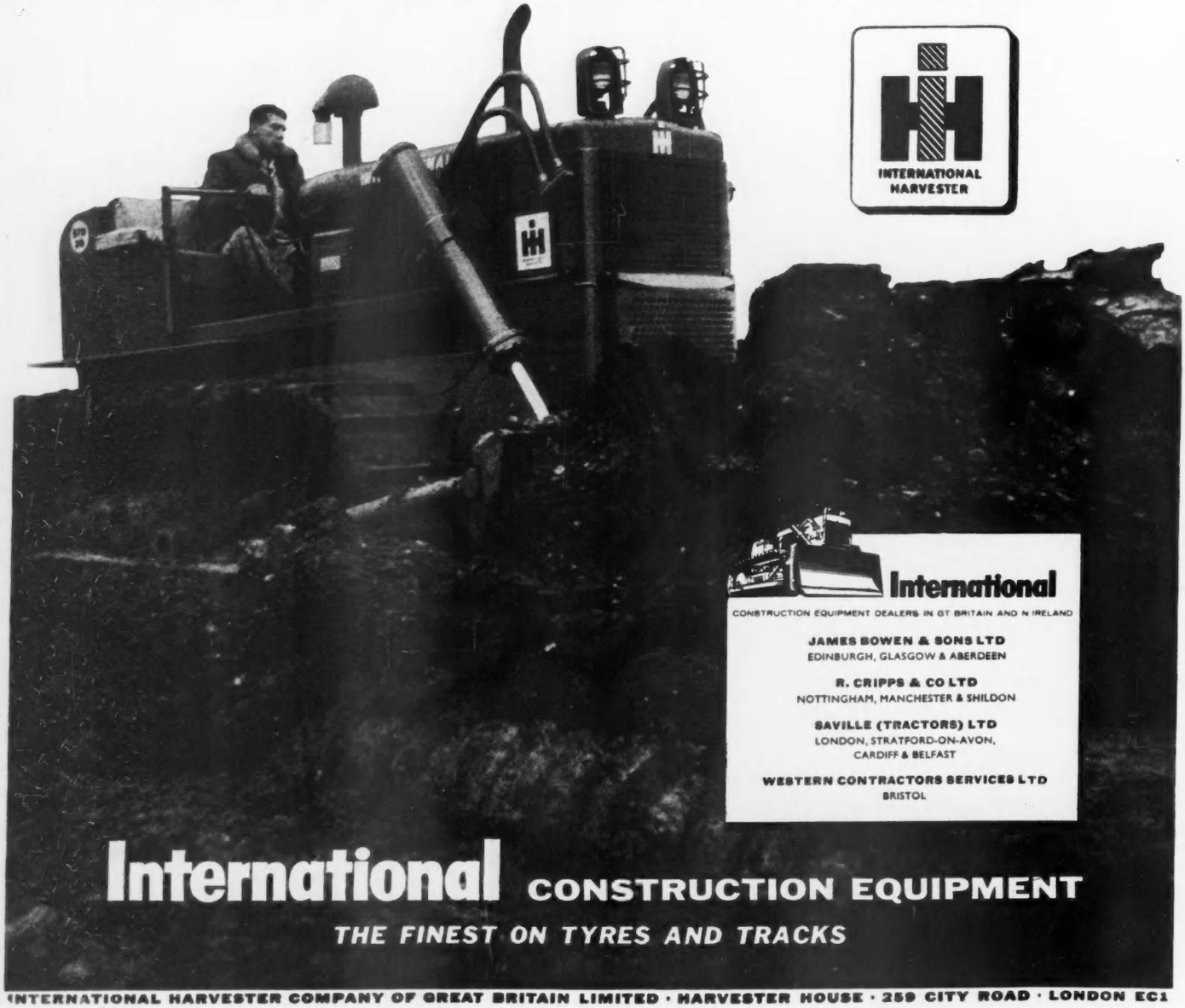

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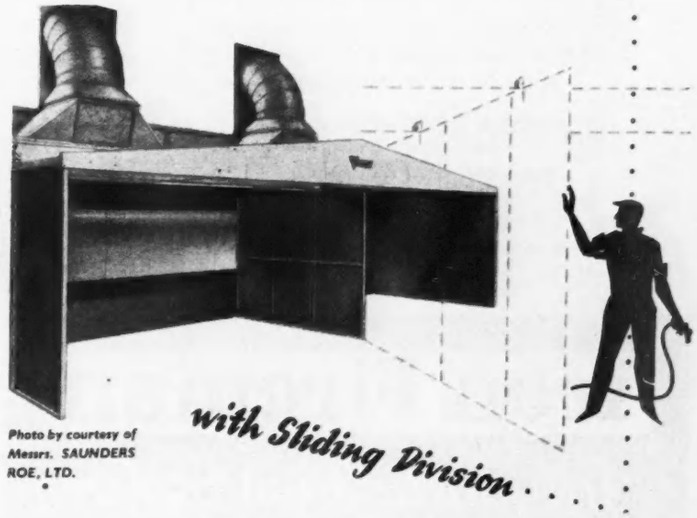

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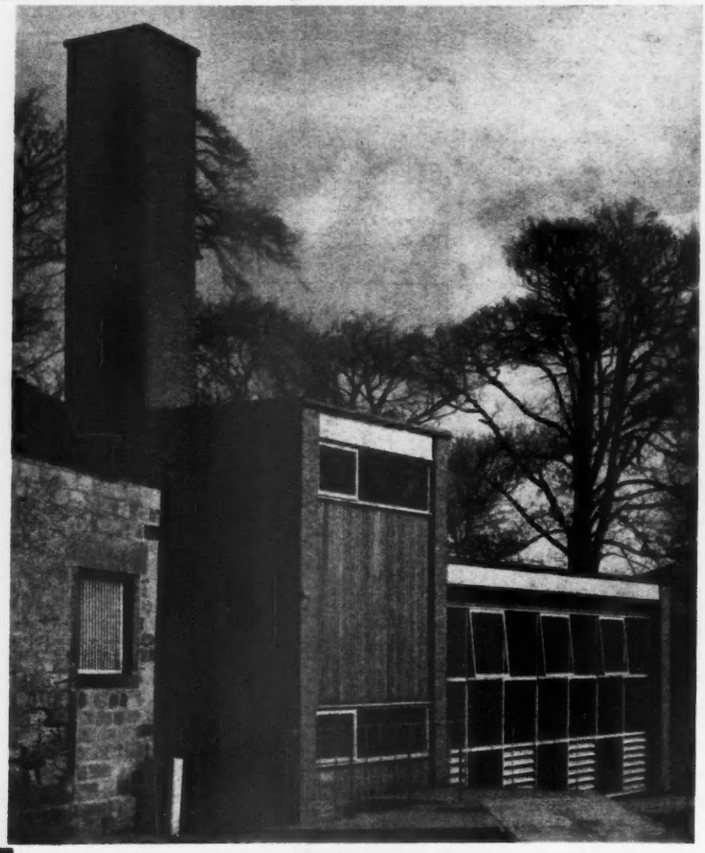

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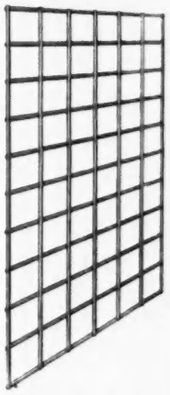

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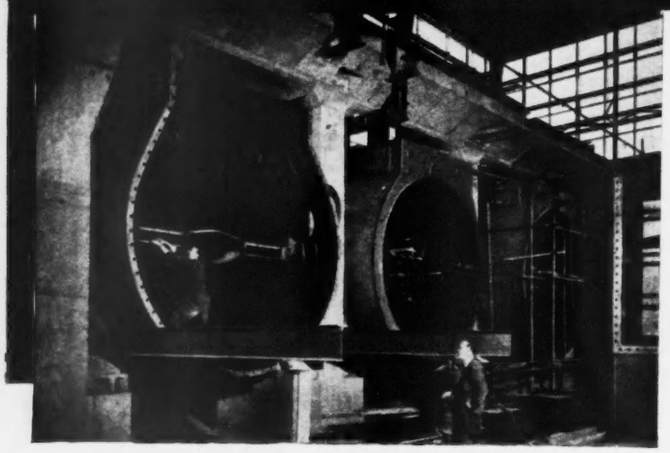

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